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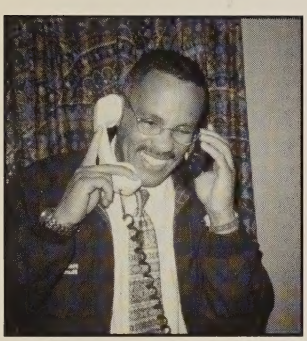
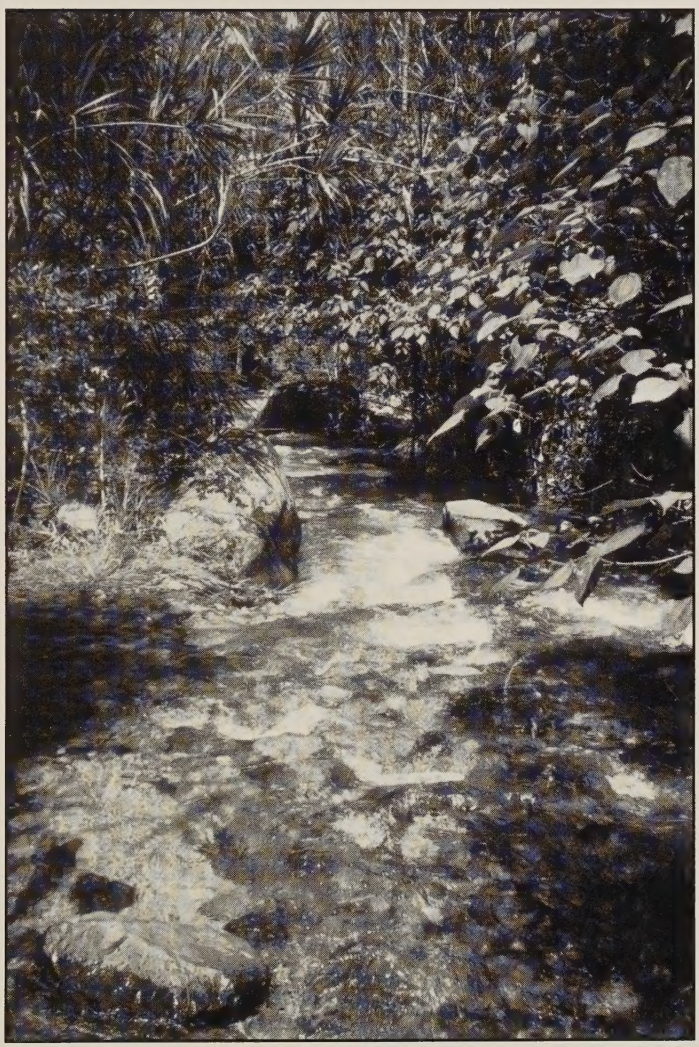
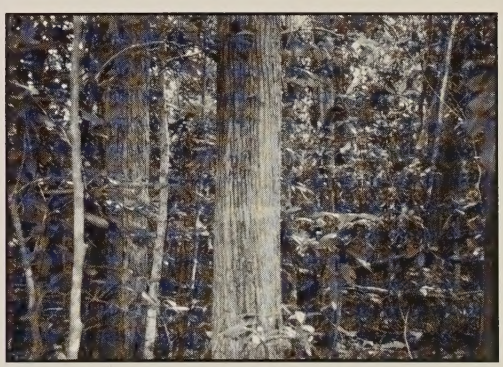
Proceedings of the Ninth Meeting of Caribbean Foresters
at the Dominican Republic
June 1–5, 1998

Biodiversity in the Caribbean: Management and Benefits



A Publication of the USDA Forest Service
International Institute of Tropical Forestry
Rio Piedras, Puerto Rico
1999

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BIODIVERSITY IN THE CARIBBEAN: MANAGEMENT AND BENEFITS

PROCEEDINGS OF THE NINTH MEETING OF CARIBBEAN FORESTERS AT THE DOMINICAN REPUBLIC

JUNE 1-5, 1998

Compiled and Edited by:
Carleen Yocum and Ariel E. Lugo
International Institute of Tropical Forestry

A Publication of the USDA Forest Service
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PREFACE

During June 1–5, 1998, 58 participants celebrated the 9th Caribbean Foresters Meeting in the Dominican Republic. Sixteen countries were represented, as well as various non-government organizations (NGOs), private firms, and multinational and national development agencies. The theme of the meeting was *Biodiversity in the Caribbean: its management and benefits*. In addition to thematic presentations for each country, four guest speakers from the USDA Forest Service, the University of Illinois, and The Nature Conservancy presented invited papers. A local research project was presented one evening, as well as a session on the basic operation and uses of global positioning and geographic information systems. The local NGO PROGRESSIO hosted the group for a 1-day field trip to the Ebano Verde Scientific Reserve, located in the scenic montane cloud forest of the Dominican Cordillera Central.

The 9th meeting of Caribbean Foresters was historic in that it was the first meeting of the series held on a Hispanic island. The Dominican hosts demonstrated the hospitality that the group has come to recognize as a strong characteristic of all Caribbean countries. The meeting also introduced a new cadre of forest officers who are now in charge of the conservation of forests and natural resources of Caribbean islands. Over the past nine meetings we have witnessed a complete turnover in leadership and a diversification of the talent involved in Caribbean forestry. Gabriel Charles, who was a pioneer Caribbean conservation leader, heading the Forestry Department in St. Lucia, and one of the founders of the Caribbean Foresters Meeting, would have been proud of the showing of this new leadership during this meeting.

Dr. Joe Wunderle, a scientist from the USDA Forest Service International Institute of Tropical Forestry, summarized well the value and importance of Caribbean island faunas. He said that they were unique, vulnerable, and exposed to many threats, but could continue to survive if the current area of forest cover in the region was maintained at least at 23 percent. Dr. Wunderle explained that the most threatened wildlife in the region depends on forest fragments and so it is important to maintain trees on the landscape. Certain agroforestry plantations provide important habitat and sustenance to Caribbean wildlife.

The extensive dialogue generated by the meeting allowed the group to identify the benefits derived from, and the challenges faced by, the conservation of biodiversity within the region. These observations, along with the group's recommended management methods to address the challenges appear in the conclusions at the end of this publication.

We thank the following people for their hospitality and for making this meeting a success: the Vice President of the Republic, Hon. Jaime David Hernández; Dr. Rhadamés Lora, Dirección General Forestal; Bernabé Mañón, Comisión Nacional Técnica Forestal; PROGRESSIO; PRONATURA; USAID; the RARE Center; US Peace Corps/DR; Esther Rojas, the Puerto Rico Conservation Foundation; and the Government of the Dominican Republic.

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OPENING REMARKS

William G. Edwards

Vice President of the Dominican Republic, Dr. Jaime David Hernández Mirabal; Mr. Paino Abreu, Director of the Dominican Agrarian Institute; Mr. Bernabe Mañon Rossi, President of the National Technical Forestry Commission; Dr. Radhames Lora Salcedo, Director of the General Forestry Direction; and other distinguished members,

On behalf of Dr. Ariel E. Lugo and the International Institute of Tropical Forestry, I am pleased to welcome you, to this 9th meeting of Caribbean Foresters, to the Dominican Republic. We are extremely grateful to the Dominican Republic for inviting us to have the meeting in this beautiful country.

Our Institute, located in Puerto Rico, is a close neighbor to the Dominican Republic. We share much in common - environments, ecosystems, and cultural heritages. Over the years our relationship has focused on the exchange of information and expertise. Recent interactions relate to line planting and stimulating development of research in the Dominican Republic with Dr. Peter Weaver. The Dominican Republic is also where Dr. Joseph Wunderle completed his pioneering work leading to guidelines for bird-friendly coffee production, which we will hear about later in the week.

The Caribbean Foresters Meetings were begun in 1982 by IITF. Our purpose was to bring together forestry practitioners from around the Caribbean and provide a venue for training and education, and the exchange of ideas on forestry issues of common interest. Other objectives of the meeting have been to disseminate research findings and stimulate regional dialogue on forestry issues. We started with eight countries and one non-governmental organization participating. At this 9th meeting we have 16 participating countries, 6 non-governmental organizations, and 7 regional and international organizations in attendance. This speaks well for the outcomes of these sessions over the past 16 years. We note within the region the following changes, all of which have been themes of past meetings: increased interest and attention to forestry matters; innovations and contributions of forestry to the national economies of some participants; and increased capacity and expertise in such areas as forest protection and management, parks and recreation, wildlife, wetlands, and the like.

This year we have chosen the theme *Biodiversity in the Caribbean: Its Management and Benefits*. The Caribbean Region has a large number of highly vulnerable endemic species. So, biodiversity is an important consideration in the international dialogue, one of the major issues in sustainable forest management, and a prime concern of everyone here today. During the course of the meeting we will explore this issue- what it means, ways to assess and monitor biodiversity, and the implications for management in our regional setting. We will have an opportunity to visit the Ebano Verde Scientific Reserve and learn how our colleagues in the Dominican Republic are approaching this issue. We look forward to the meeting, both for the professional and technical presentations and for the opportunities we will have to get acquainted and share information among the region's forestry communities.

At the outset we would like to recognize the co-sponsors of the meeting: CONATEF, RARE, The Nature Conservancy, USAID, PRONATURA, PROGRESSIO, The Peace Corps in the Dominican Republic, Dirección General Forestal, Plan Quisqueya Verde, Dirección Nacional de Parques, Instituto Agrario Dominicano, and Fundación Falconbridge. Lastly, we all owe a big "thank you" to Ester Rojas and the Puerto Rico Conservation Foundation for having done a superb job with the logistics and enabling all of us to be here today.

THE CURRENT STATUS OF BIODIVERSITY MANAGEMENT IN ANTIGUA AND BARBUDA

McRonnie Henry and Everette Williams

INTRODUCTION

The United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro, Brazil, in June 1992, produced five governmental agreements (Earth Council 1994). One of these was the Convention on Biological Diversity, which is based on the recognition of the intrinsic value of biological diversity and its importance for maintaining life-sustaining systems in the biosphere. The objectives of the Convention, as set forth in Article 1, include the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising out of the utilization of biological resources.

The government of Antigua and Barbuda signed the Convention on June 5, 1992 and subsequently ratified it on the March 9, 1993. This confirmed the government's desire to promote wise stewardship of Antigua's and Barbuda's natural resources, in this case, the conservation and sustainable utilization of the country's biological resources.

Several qualitative studies on the country's fauna and flora have been conducted in the past. More recently, however, there has been some effort to quantify various biological components. Notwithstanding this effort, there is much work to be done in obtaining both quantitative and qualitative information on the population dynamics and habitat distribution of the country's fauna and on the status of their respective ecosystems, including floral composition and distribution. Consequently, there is urgent need to accomplish the following activities:

- Compile existing information on the country's biological resources and establish or designate a lead agency to act as a clearing-house that can be accessed by other interested parties.
- Assess the status of Antigua and Barbuda's fauna and flora to determine the long-term impact of natural disasters (hurricanes, drought, *etc.*) and human stresses on these populations and their habitats.
- Initiate training in the planning, conservation, monitoring, and management of biodiversity for land-use planners, policy makers, biodiversity managers, and other relevant personnel.

AGENCIES INVOLVED IN THE MANAGEMENT AND CONSERVATION OF BIOLOGICAL DIVERSITY

In Antigua and Barbuda, four main agencies are actively involved in the management and conservation of biological diversity. Two of these are governmental agencies: the Forestry and Fisheries Divisions within the Ministry of Agriculture. The other two agencies are the Environmental Awareness Group (EAG), which is a local, non-governmental organization (NGO), and the Island Resources Foundation (IRF), a regional NGO. In 1993, the Foundation established biodiversity conservation as a primary program sector for its work in the Eastern Caribbean.

The Forestry Division has the following goals:

- Protect and conserve the country's natural resources, some of which are in a critical state, *e.g.* forests, water, and soil.
- Halt and reverse the degradation of the environment, including the decline in ecosystem which jeopardizes the local food supply and ultimately the quality of life for Antiguans and Barbudans.
- Increase the contribution of the forestry sector to the social and economic development of the country.
- Encourage positive attitudes towards the country's natural resources, including biological resources, among the public in general, but more particularly, politicians, school teachers, and other molders of public opinion.

- Cooperate with other agencies, both governmental and non-governmental, in order to widen the range of participation in the conservation and sustainable use of biological resources and in environmental management issues.
- Promote scientific research on biological resources.

The Fisheries Division has the following goals:

- Develop and increase the potential of marine resources to meet human nutritional needs as well as social, economic, and development goals.
- Maintain or restore populations of marine species at levels that can produce the maximum sustainable yield as qualified by relevant environmental and economic factors, taking into consideration relationships among species.
- Ensure that the fishing industry is involved in policy- and decision-making for fisheries and coastal zone management.
- Assimilate traditional knowledge and interests of local communities, small-scale artisanal fisheries, and indigenous people into development and management programmes.
- Ensure effective monitoring and law enforcement in the fishing activities.
- Promote scientific research on fisheries resources.
- Protect and restore endangered marine species (especially turtles).
- Promote the development and use of selective fishing gear and practises that minimize waste in the catch of target species and minimize by-catch of non-target species.
- Cooperate with other nations in managing shared or highly migratory stock.
- Preserve rare or fragile ecosystems as well as habitats and other ecologically sensitive areas, especially coral reef ecosystems, estuaries, mangroves, seagrass beds, and other spawning and nursery areas (Fisheries Division 1998).

The Environmental Awareness Group (EAG) has the following goals:

- Raise awareness of the importance of the natural resources of Antigua and Barbuda and the need for their conservation.
- Support and undertake conservation and natural resource management projects in a participatory manner.
- Advocate the formulation and implementation of policies that promote sustainable development in Antigua and Barbuda.
- Serve as a clearing-house for environmental information to assist the government, non-governmental bodies, and students in conserving the natural heritage of Antigua and Barbuda.

The IRF Biodiversity Conservation Programme's overall goal is to facilitate and strengthen national decision-making on strategic environmental issues, including the protection and preservation of threatened natural resources (IRF 1998). The programme has four important elements:

- Support technical studies and research.
- Expand the biodiversity information base by encouraging more effective data assembly and interpretation.
- Build institutional and individual resource capabilities.
- Link public and private-sector interest in support of biodiversity conservation programmes.

MAJOR INITIATIVES RELATING TO THE MANAGEMENT AND CONSERVATION OF BIOLOGICAL DIVERSITY

Some of the major initiatives relating to the management and conservation of the country's biological resources are summarized below. It is important to note that all four agencies identified above closely collaborate on many of these initiatives.

The Antiguan Racer (*Alsophis antiguae*) Conservation Project

In 1995, the EAG along with other local, regional, and international organizations, including Fauna and Flora International UK, the Antigua Forestry Division, the Jersey Wildlife Preservation Trust, and the Island Resources Foundation, embarked on the Antiguan Racer Conservation Project. The Antiguan Racer (an endemic snake) is one of the world's rarest and most endangered

species. Extinct in the main island of Antigua, due to predation by mongoose, cats, and rats, it is now believed to be restricted to a single, tiny offshore island approximately 0.3 km^2. This remaining population was also threatened by introduced rats. The aim of the Antiguan Racer Conservation Project is to ensure the survival of the species and its habitat. Additionally, it aims to enhance biodiversity conservation efforts in Antigua and Barbuda, with particular focus on the offshore islands of Antigua. The Racer Conservation Project uses an integrated approach that combines biological research, environmental restoration, public education, conservation breeding, and institutional capacity building.

The Wallings Forest Conservation Project

The Wallings Forest in Antigua is a unique, multi-purpose area of natural, cultural, historical, environmental, educational, biological, and recreational significance. The Ministry of Agriculture (Forestry Division) secured a small grant from the International Institute of Tropical Forestry (IITF), Puerto Rico that was used, along with local government input, to undertake the Wallings Conservation Project. The objectives of the project are to preserve the biological diversity of the forest by sustainably managing its water, plant, and wildlife resources and to capitalize on its potential for environmental education, ecotourism, and recreational opportunities for local residents.

Private Sector Support for Wetland Conservation

A project to build private sector support for wetlands conservation was started in 1997 to involve hoteliers in the conservation of mangroves while providing added attractions for guests and locals. This project is funded by the Caribbean Natural Resources Institute (CANARI) and the Inter-American Foundation (IAF). The project involves interpretative displays and participatory monitoring programmes involving employees and guests. Merchandise depicting mangrove flora and fauna will be sold in gift shops to help further conservation efforts.

EAG/GARDC Agroforestry Project

The Gilberts Agricultural and Rural Development Center (GARDC) in collaboration with the Forestry Division and the EAG has initiated an agroforestry project. This project involves producing trees, promoting their use by farmers in various agroforestry schemes, and training farmers and extension officers in agroforestry techniques. Recently, the EAG initiated an in-school forestry programme to improve youth skills in tree care and propagation. This programme will provide trees for schools and community tree-planting projects.

National Biodiversity Strategy and Action Plan

A Project funded by the Global Environmental Facility (GEF) has just been approved to formulate a National Biodiversity Strategy and Action Plan through a fully participatory process that will include line ministries, the private sector and NGO's.

Other Activities

The Bird Island Marine Reserve and Wildlife Sanctuary

The Island Resources Foundation assisted the government of Antigua and Barbuda in an OAS (Organization of American States)-funded project to establish the proposed Bird Island Marine Reserve and Wildlife Sanctuary by preparing the management plan for the proposed protected area.

Survey of the Bats of Antigua and Barbuda

This project involved the survey of the bats Antigua and Barbuda and included the conservation status and priorities for seven species.

Survey of Reef Sites

Nine reef sites were surveyed in order to establish baseline data, evaluate monitoring options, and offer recommendations for ongoing marine resource management.

Preservation of the Codrington Lagoon in Barbuda

This involved designing a project to preserve the Codrington Lagoon in Barbuda, home of the largest colony of magnificent frigatebirds in the Caribbean.

National Vegetation Classification Scheme

A proposed national vegetation classification scheme has been prepared.

National Biodiversity Profile Project

Under this project, a Biodiversity Profile that summarizes information about the country's flora, fauna, and habitats has been prepared.

Wetlands Monitoring and Conservation Programme

A United Nations Development Programme (UNDP)/GEF - funded project was begun to assess, classify, and map Antigua and Barbuda's wetlands. In 1997, a nation-wide inventory of the status (biophysical and community use) of all major wetland sites in Antigua and Barbuda was initiated.

Artificial Reef at Mercer's Creek

The EAG and Seaton's Community group have begun to develop an artificial reef at Mercer's Creek that will use more than 10,000 used tires. The project received technical assistance and funding from CANARI. The reef is already benefitting local fisheries and improving recreational diving.

CFRAMP (Caribbean Fisheries Resources Assessment and Management Programme)

This programme, funded by CIDA (Canadian International Development Agency), includes in its goal establishing a database on fish catch and effort throughout the Caricom region. Other activities of CFRAMP include general habitat assessment of Antigua and Barbuda, using aerial photography, satellite imagery, and ground truthing.

COSALC (Coast and Beach Stability in the Lesser Antilles)

UNESCO and the University of Puerto Rico Sea Grant College Program sponsor this regional project, which includes Antigua and Barbuda. The project develops local capacity to measure, assesses, and manage beach resources within a framework of integrated coastal management. The Fisheries Division and the DCA (Development Control Authority) established a regular beach-monitoring program in Antigua in 1991 and in Barbuda in 1995.

OECS-NRMU Coastal Resources Management Project

For the OECS (Organization of Eastern Caribbean States) countries, the OECS-NRMU will be preparing coastal inventories using aerial photographs, satellite imagery, and ground truthing. These inventories are expected to be incorporated into the country's geographical information system.

UNEP Impacts and Adaptations Country Study

Antigua participated in an 18-month-long study that focused on how climate change will impact several different sectors within the country, including the coastal zone, fisheries, water resources, human health, human settlements, and agriculture.

CPACC (Caribbean: Planning for Adaptation to Climate Change)

This 6-year project began early in 1997 and is funded by the GEF and the World Bank but is executed by the OAS. For Antigua and Barbuda, the project includes measuring sea level changes through the establishment of a tide gauge, climate monitoring, a partial resource inventory, strengthening of coastal zone management, and an economic valuation of coastal resources.

University of Georgia Sea Turtle Project

Since 1987, The University of Georgia, in conjunction with the Jumby Bay Resort, has been participating in a project that monitors the nesting hawksbill turtle population at Pasture Bay, Long Island.

AREAS OF URGENT NEED

In undertaking the various projects and programmes highlighted above, the following needs have been identified as requiring urgent attention:

- the adoption of relevant policies, backed by appropriate legislation and regulatory mechanisms, that are consistent with the current needs for managing and conserving biological diversity
- training in the measurement and monitoring of biological resources

- training in the economic valuation of natural resources, particularly, biological resources
- access to and effective use of modern information technologies - computer databases, geographic information systems (GIS), Internet, *etc.*
- adequate financial resources to facilitate monitoring, managing and conserving the country's natural resources

REFERENCES

Earth Council, and Inter-American Institute for Cooperation on Agriculture (IICA). 1994. The Earth Summit: ECO 92 Different Visions. San Jose, Costa Rica.

Fisheries Division. 1998. Goals of fisheries management handout. 1998. Unpublished.

Island Resources Foundation. 1998. Draft biodiversity handout. Unpublished.

BARBADOS REPORT ON BIODIVERSITY IN THE CARIBBEAN: ITS MANAGEMENT AND BENEFITS

Nigel Jones

INTRODUCTION

Inasmuch as biological resources provide most if not all the basic requirements for man's existence, as foresters sharing this common view we should endeavor to see that "biological offenders" (those involved in illegal activities) are not allowed to flourish in a climate of impunity. Within the last decade or so, several interest groups comprising foresters by profession or association continued to articulate the urgent need for legislation to run parallel with biological policies.

The benefits of biological resources are no doubt transparent, especially to the millions of rural people found scattered throughout the developing world. Yet an effective management system that provides for sustainable utilization of these resources is still to become a reality. To devise such a system, we first need to assess and quantify the existing resources. Then, we can categorize them and evaluate each category. In general, values fit into two broad categories: direct and indirect. Direct values relate to tangible products, such as timber, food, medicines, *etc.*, while the indirect values encompass intangible products, such as scientific research, recreation, and habitat protection.

Depending on the local situation, our management plan should priortize the values best suited for a particular geographical region. For example, most Barbadians feel that the indirect values of the Scotland District (figs. 1 and 2) by far out weigh those of the direct. Regrettably, however, quantifying and evaluating biodiversity in Barbados are not yet seen as national priorities, resulting to a large extent in the loss of so many natural ecosystems.

Assuming that we have assessed our biological resources and their natural environs, our next priority should be to focus on threats to their existence. Threats in the broad sense of the word can either be natural or human-caused. The geographical location of Barbados has so far allowed us to elude most of the natural threats, such as hurricanes, earthquakes, severe flooding, *etc.* However, the physical development policy currently being pursued to facilitate tourism and other forms of economic activity is causing as much destruction as natural disasters experienced by our neighbors.

Realizing how valuable the resources are and the many threats that can exist, it should be possible to establish a conservation policy. But before establishing priorities and parameters to formulate policy, we should ensure that our database is reliable so that conservation can be undertaken without hesitation or fear.

ASSESSMENT OF BIODIVERSITY IN BARBADOS

Within the last 2 decades, the landscape of Barbados has been significantly altered. This suggests that any further delay in inventory work will no doubt result in the extinction of many more valuable species. About 700 wild plants are known to exist, and the last inventory completed by FAO in 1991, recorded 289 faunal species. This latter number, however, is not quite accurate since question marks and the term "many" replaced actual numbers when the researcher was unsure of an exact number.

Inventory work on Barbados' flora began as early as 1657 when Richard Ligon in his book *A True and Exact History of the Island of Barbados* described a large number of the flowering plants. Since then, there have been several studies, some of the more comprehensive ones being done by E.G.B. Gooding. In more recent times, however, modern technology has been used to measure the status of biodiversity in Barbados. GIS systems are currently being used to detect sensitive ecological sites located within the boundary of the proposed national park.

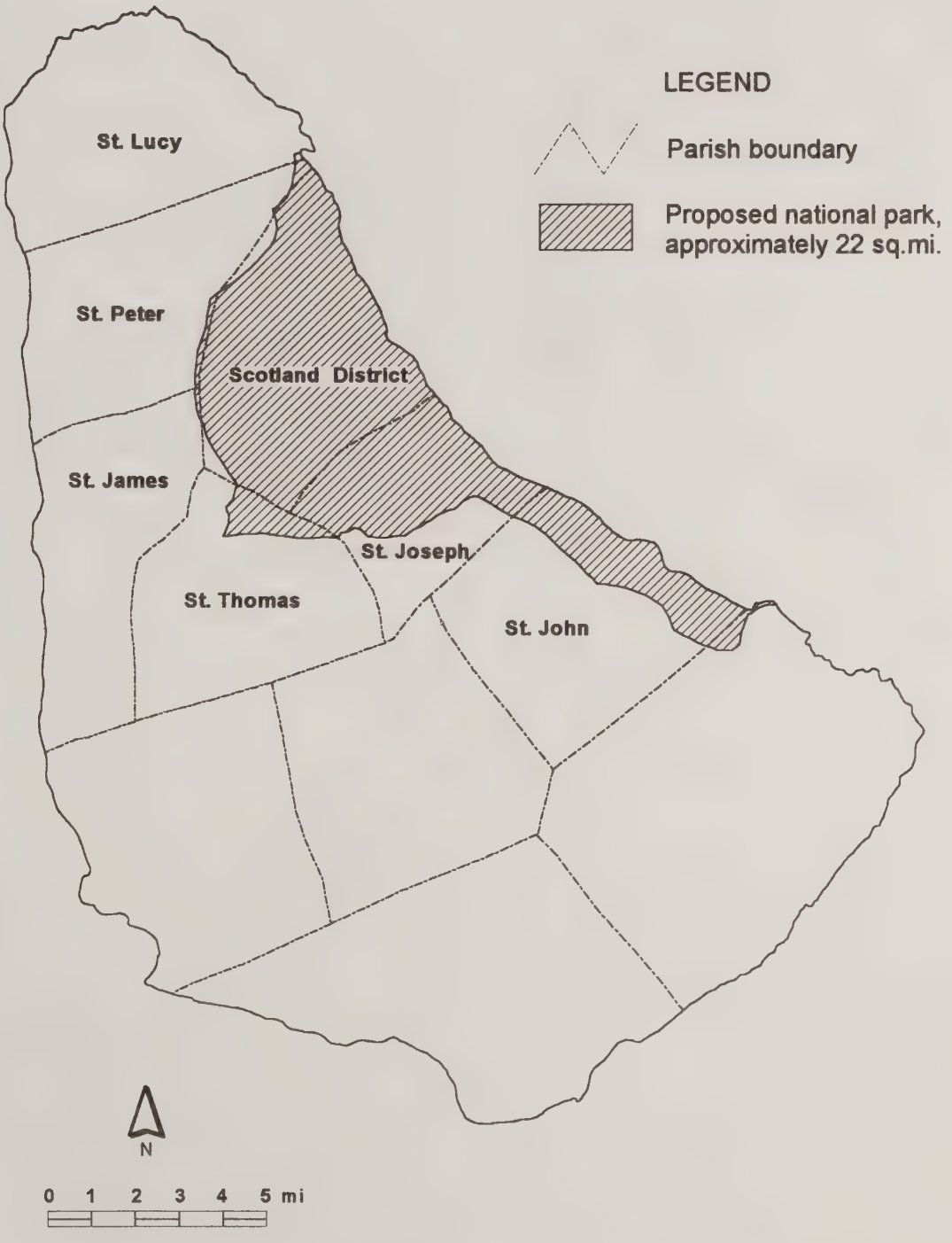


Figure 1. - Scotland District. (Author's original map, adapted by IITF, 1997)

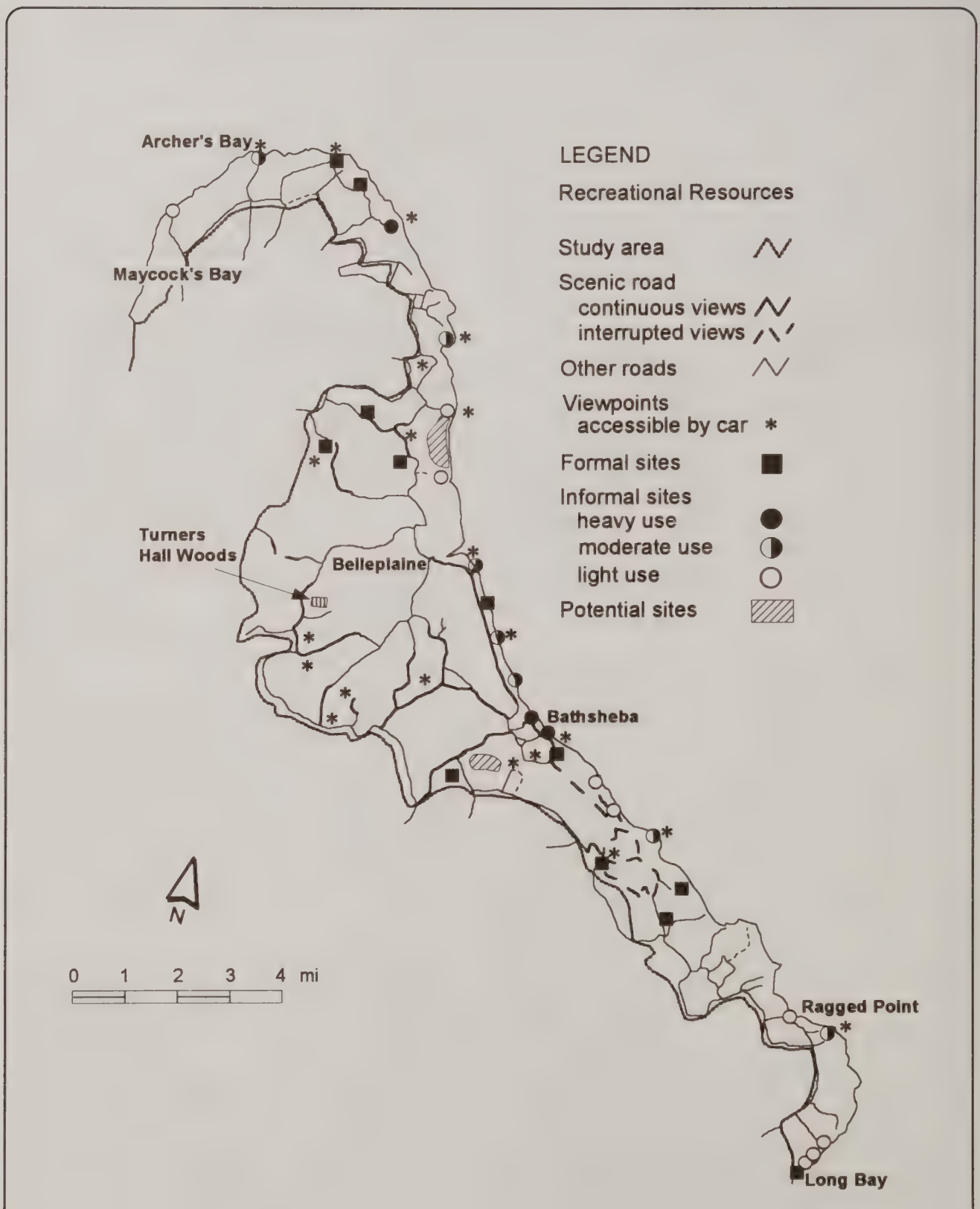


Figure 2. - Enlargement of proposed national park, Scotland District. (Author's original map with adaptions by IITF, 1997)

Despite the intensive land clearing soon after colonization, Barbados still possesses a wide range of ecological habitats, some of the more important ones include the following:

Turner's Hall Wood. This 30-ha woodland located within the Scotland District is by far the most diverse terrestrial ecosystem on the island today. On this phenomenal site, the more than 100 wild plants known to exist form a unique, multi-storied woodland. The tree stratum is clearly divided into two stories comprising both deciduous and evergreen species, the former being the dominant while the latter forms a dense, co-dominant canopy. Both the shrub and herb layers are sporadic, probably resulting from continuous shade being provided by the co-dominant stratum. The sparse distribution of the lower strata along the wood floor clearly indicates that many species are light-demanders and are therefore unable to survive under the closed, evergreen canopy. What is unusual, however, is the paucity of lianas, epiphytes, and thallophyes normally associated with similar ecosystems. What little is known so far about the fauna in this area is enough to suggest that the species found at Turner's Hall are no different from those found in other woodlands around Barbados.

Forest and Under-Cliff Woods. The Under-Cliff Woodland is a continuous stretch of mesophytic vegetation some 9 km long covering an area of about 280 ha, most of which lies beneath the Kackleton's Cliff. Although in the past some areas were exploited for timber and fuelwood, most of this seasonal forest still remains untouched. The natural flora of this woodland resembles that of Turner's Hall Wood, and early botanists felt that this type of vegetation once covered the vast interior of Barbados. Along the exposed edge of the woods the vegetation tends to xerophytic, but closer to the base of the cliff, where there is seepage of water from the limestone, species of a more mesophytic character appear. In 1963, enrichment planting was done on 39 ha near the northern end of this woodland in an area known as Joes River. This has enriched the flora diversity and consequently the fauna has also increased. An early morning or late afternoon visit to this area will reveal the presence of several mammals, birds, amphibians, reptiles, arthropods, crustaceans, mollusks, and insects. Viewing the northern portion of the Scotland District from the Joes River area, one will notice several vast tracks of secondary vegetation, mainly *Leucaena leucocephala*, clearly indicating that the landscape has been altered from time to time. Outside the Scotland District on the limestone cap, several small, pure stands of mahogany and casuarina were planted many years ago around sugar estates as a source of fuel. Today, most of these stands have matured and, apart from their scenic value, they also provide shade and nesting sites for birds.

Gullies and ravines. Although the extent of gully vegetation remains unknown, it is estimated to total some 150 km in length. Most wild plants found within the island's gully network are native species that were used by previous generations for medicinal purposes. Similar to Turner's Hall, most of these gullies are multi-storied and diverse in both flora and fauna. For example, 33 out of the 37 ferns known to exist in Barbados are located within the gully network. Moreover, the lone mature mastic tree (*Sideroxylon foetidissimum*) remaining in Barbados is located at the Sion Hill gully in St. James. The many animals in these habitats can be ascribed to the richness of flora, which provides abundant food for wildlife. Most nature lovers who normally frequent these ecosystems believe that most of the island's fauna resides within the gully network.

Littoral woodlands. Littoral forests have suffered the same fate as the other plant communities in Barbados, that is, they were subjected to early deforestation. The legacy now left behind is characterized by the sparsely distributed pockets of woodlands along the island's coastline. Three conspicuous communities of the remaining coastal forests are located at Cluffs and Bath on the windward side of the island and Batt's Rock on the leeward. The dominant plant species of the windward side facing the Atlantic Ocean are mainly sea grape (*Coccoloba uvifera*) and whitewood (*Tabebuia heterophylla*), both highly wind and salt tolerant. Manchineel (*Hippomane mancinella*) dominates the leeward coastline. Several bird and crab species are abundant in these habitats. But what is more ecologically significant is that they provide a comfortable nesting site between May and October for the endangered hawksbill sea turtle.

Coastal mangroves. Physical development along the coastal areas of Barbados has reduced most mangrove stands to less than one ha (fig. 3). Today, there are only two coastal wetlands in Barbados of any significance and they are located at Graeme Hall and Chancery Lane, both on the southern coastline. Graeme Hall wetland is approximately 31.6 ha (fig. 3) and can be regarded as the perfect example of a tropical mangrove swamp. Red mangrove *(Rhizophora mangle)*, found only at this site, is by far the dominant species, although in some areas the white mangrove (*Laguncularia racemosa*) is evident. Conservation of this ecosystem has resulted in a steady increase in birds over the years and what is even more ecologically important is the fact that this area is the residence of the yellow warbler (*Dendrocia petechia*), one of the few endemic birds known to our shores. Currently, plans are underway to develop the area into a bird sanctuary, and this is expected to further boost our nature-based tourism, which is now starting to show some economic potential. Chancery Lane mangrove is almost half the size of Graeme Hall (16 ha) and may become even smaller by year end as there are plans to fill a portion of this wetland to facilitate physical development. The only mangrove species known to exist in this area is the bottom mangrove (*Conocarpus erectus*).

Current and Possible Future Benefits of Biodiversity to Barbados

Benefits currently being derived from biodiversity in Barbados range far and wide. Most of the woodlands are multi-functional, providing benefits ranging from economic to educational. For example, the nature trail at Turner's Hall is currently being used for both nature walks and horse riding. Based on the annual increase in nature tourists, especially horse riders, one can conclude that economic benefits are satisfactory. Horse riding, however, should be controlled within the limits of carrying capacity during the dry season and totally prohibited during the wet season, as the horses hoofs tend to deface the trail during the wetter months of the year.

From an educational standpoint, several research projects can be carried out at Turner's Hall to benefit a wide range of local and regional students. For example, Barbados is about to update its species list, presenting a fine opportunity for researchers to quantify the existing epiphyte populations and evaluate their relationships with their hosts and the various biological communities living in harmony with the different epiphytic species. This kind of research is urgently needed if our inventory is to be accurate and up-to-date. The Under-Cliff Woodland, also located within the Scotland District, can be used for similar research projects. In addition to the research possibilities, however, this vegetation also provides shelter for wildlife and it helps stabilize the steep, vulnerable slopes on which it exists.

Gully vegetation has long been a boon to Barbadian fishermen. This unique relationship has cultural, historical, and economic significance. From time immemorial, Barbadian fishermen have been collecting at least three known crab species from gully ecosystems and using them as fish bait, especially for near-shore fish species.

Although the benefits of coastal vegetation are not apparent to the average Barbadian, these ecosystems will be needed now more than ever. As a result of physical development along the shoreline, more and more beaches are being eroded. Erosion is also expected to increase as sea level is predicted to gradually rise. Thus, our coastal vegetation will be needed now more then ever to alleviate the problem of increasing beach erosion. Coastal forests (including mangroves) will also be needed to cushion the impact of frequent storm-force winds that may be associated with the changing global climate.

Finally, wetlands around Barbados are currently being utilized for both cultural and economic benefits. The nature ride that passes through Turner's Hall Woods finishes at the Long Pond wetland located on the northeastern coast of the island. While here, visitors are encouraged to sail from one end of the pond to another using rafts made from local wood and wood products. It is my understanding that the demand for such sailing is increasing and this activity is expected to spread to other wetlands around the island. Several crab species are harvested at various times of the year. It should be mentioned, however, that crab is not a traditional Barbadian dish, so one

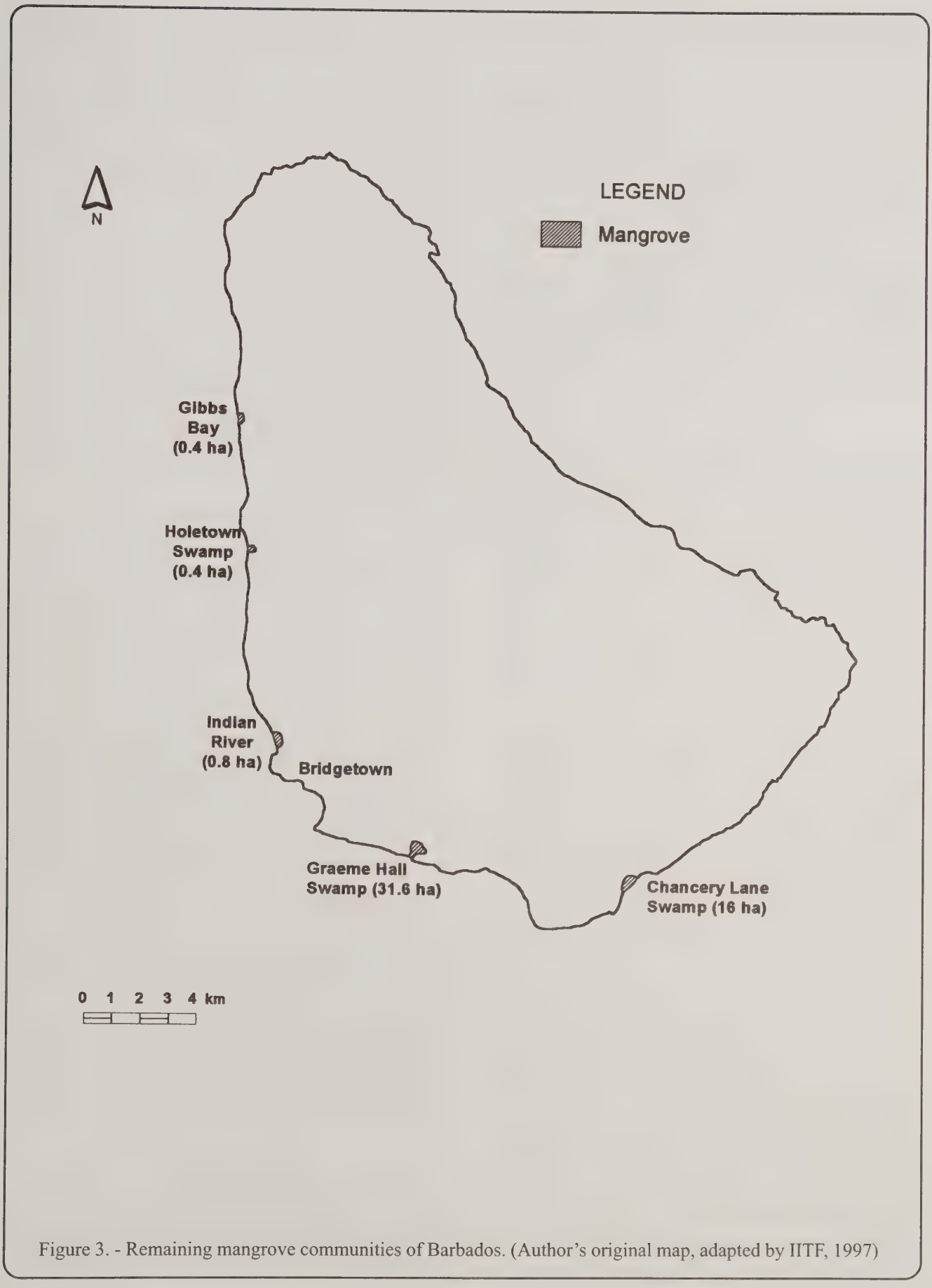


Figure 3. - Remaining mangrove communities of Barbados. (Author's original map, adapted by IITF, 1997)

can view crab harvesting from a social, cultural, and recreational standpoint.

THREATS TO BIODIVERSITY IN BARBADOS

Most of the threats to biological communities are common and, in most cases, interrelated. Some of the most common ones are land-use changes, chemical pollution, over harvesting, introduction of new species, climate change, and population explosion.

Land-Use Changes

Over the years, a significant amount of habitat alteration has taken place in Barbados, primarily to facilitate tourism, agriculture, and housing.

1. Tourism. Tourist arrivals are increasing steadily year after year, hence more and more hotels and guest houses are being constructed at the expense of coastal forest. Interior woodlands are also being replaced by golf courses and other facilities to accommodate the visitor. Within the last decade, a significant amount of unmeasured deforestation has taken place so, as mentioned earlier, "the time for inventory work is now."
2. Agriculture. Agro-ecosystems are renowned for encroaching on forests. In Barbados, this started early, and over the years continued to compromise the forest resource. Not only did agricultural practices result in incessant deforestation, but the indiscriminate use of persistent agro-chemicals around sensitive ecosystems is now causing serious concern.
3. Housing. As the standard of living in Barbados continues to escalate, more and more Barbadians are owning their homes. The high demand for houses will obviously parallel the demand to deforest, and unless housing policy is changed, one can expect further threat to the island's biological diversity.

Chemical Pollution and Illegal Dumping

Both marine and terrestrial ecosystems are under severe threat as a result of chemical pollution and illegal dumping. For example, several near-shore benthonic species are constantly being exposed to concentrated detergents released from the kitchens and laundries of hotels. Agro-chemicals over the years have also continued to threaten most of the island's terrestrial ecosystems, especially the fresh-water wetlands, which provide water to adjacent agricultural land. Illegal dumping in oceans and gullies is beginning to jeopardize both flora and fauna living in those ecosystems. Currently, garbage along gully floors is blocking the regular water-ways following heavy rains. This forces the runoff to change its natural course, resulting in severe bank erosion and uprooting many valuable plant species. This solid waste is also causing other ecological problems; for example, several plant species along the gully floor that normally help filter runoff are being suffocated by this foreign material. As a result, several pollutants, including plastics, are having easier access to the marine environment.

Over-Harvesting

This is not a serious problem in Barbados as most of our biological resources have indirect values. However, one crop that is believed to be over harvested is the sea egg, which may well be one of the many reasons for its absence on our reefs today.

Introduced Species

Several plant and animal species have been introduced to Barbados. Problems always tend to surface when species are introduced. In Barbados, for example, the mongoose was introduced primarily to control the escalating snake population. Today, snakes in Barbados are practically extinct, while the mongoose can be seen almost everywhere. Forest officials in Barbados are now keeping a close eye on the neem plant (*Azadirachta indica*). This species is considered to be very aggressive as its fruits are both regular and abundant, yet more and more Barbadians are using it in reforestation projects. Since we know that most introduced species tend to upset ecological balances, we must consider species introduction as a last resort.

Climate Change

This may be the biggest threat to the region's biological diversity. As a result of the severe water shortage experienced in 1998 in Barbados, both farmland and forests were seriously affected. Sugar

yields were some of the lowest recorded in recent times. Non-sugar agriculture also suffered a serious setback; and one event still fresh on the minds of most Barbadians is the killing of thousands of poultry birds by heat, supposed brought on by the El Niño freak weather. Most recent reforestation work has failed from lack of sufficient rain. With strain already on the ground water supply, Barbadians are prohibited from using domestic water for irrigation. Climate change in the future is expected to have a significant impact on the island's flora and fauna.

Population Explosion

Indeed, the global population is increasing every year. Earlier predictions were that at the start of the new millenium, the world's population would be approximately six billion. Today, that figure has already been surpassed. Fortunately, Barbados' population remained steady over the years. However, when compared to our neighbors in terms of size and population, Barbados can still be regarded as an over-populated state. This, coupled with the fact that the average Barbadian is looking forward to owning his or her own home, will no doubt have a negative impact on the island's biota. From a global standpoint, continuous population growth will obviously increase the demand for more biological resources. Already, productive habitats are being degraded at alarming rates because of natural and human activities. The big question now being asked: Can these once productive ecosystems provide enough biological resources to sustain man's existence? Only time will tell.

CONSERVATION POLICY TO MANAGE BIODIVERSITY IN BARBADOS

Individual states must first seek to strike a balance between conservation and production. This is often difficult to achieve as most governments show greater interest in economic development than in conservation.

In Barbados, as mentioned earlier, our biological resources provide mainly intangible benefits and so they are considered secondary. The job of the local forester, therefore, is to try to convince policy makers that our remaining biological resources, with sustainable management, can provide important social, cultural, and economic benefits to the Barbadian society. Since most Barbadians, including policy makers, live in "environmental darkness", light should be provided at the earliest possible time - and that time is now. In the past, several projects were unsuccessful because experts refused to consult with local people, and regrettably, most of those experts were from foreign countries. The recent resignation of President Suharto of Indonesia clearly indicates that *people, participation, and policy must always run parallel.* A comprehensive management policy should therefore focus on training to achieve institutional strengthening, public education, and legislation.

Training to Achieve Institutional Strengthening

This area should be given paramount attention as the success of all other activities relies heavily on our trained personnel. Unfortunately, few persons in Barbados so far have been trained in biological conservation. It is for this reason we are finding great difficulty in trying to convince both policy makers and the general public of the necessity to preserve critical ecosystems.

National park establishment is one of the many approaches to conservation, and Barbados is currently making great strides in this area. Regrettably, however, most of the key players concerned with the national park are non-nationals, clearly reflecting the paucity of trained nationals. One can view this deficiency being used by the policy makers to avoid opposition when critical environmental decisions are to be made.

Over the years, several biological communities in Barbados were either altered or totally obliterated to facilitate physical development. This action went on unnoticed for decades, and policy makers expect it to continue since conservation is still a dark area to most Barbadians. Although more and more members of the local population are taking part in environmental programmes, the fact remains that most of them are untrained and therefore viewed only as laymen, making it difficult for them to influence any policy decision. For example, how many of our nationals are equipped with the skills to identify

ecologically sensitive areas (ESAs); design a management plan for ESAs that would bring about social, cultural, ecological, economic, and environmental rewards; or design and manage seed banks and zoological and botanical gardens for both *in situ* and *ex situ* conservation? These examples highlight the importance of training and how it may influence decision-making. Institutions can only function effectively if their staff members are trained to deal with the many problems that may surface from time to time. Foresters and other biological specialists are urgently needed in a number of governmental and non-governmental institutions, and until this need is met we will continue to play a dangerous guessing game with the island's biodiversity.

Public Education

The local population can only participate in a meaningful way if they know why, how, and when. One should always know why he/she is doing something, how it should be done, and when it should be done. Let us assume, for example, an environmental project is about to begin and the aim of this project is to generate economic activity in an ecologically sensitive area. Before implementation, the general public should be well informed via media programmes. It may be necessary to televise similar successful projects done in other countries so that target groups are encouraged to participate where ever possible. Following the media coverage, the experts must reinforce the point by conducting regular seminars for interested individuals and groups. Based on the feedback, you can now determine whether implementation will go ahead as planned or if it should be suspended until later. On completion of the seminars, each community group should know exactly what it has to do, how it is to be done, and when it is to be done. Unfortunately, this hardly ever happens in Barbados. For example, a trail network to enhance ecotourism is currently being planned for the proposed national park (which is about to become a reality any time now). Based on reliable information received so far, none of the environmental groups that may have an interest in participating has been informed as yet. It has also been alleged that private land owners within the park whose land is required for various projects have not as yet received any communication.

If the public education campaign had been properly organized in the first place, land owners by now would have known of the possible changes in land use and the concessions that will be granted to them. Also, community groups by now would know what kind of assistance they will be expected to give. This neglect clearly demonstrates the lack of consultation and communication that is responsible for most if not all the duplication occurring in many government departments today. There are several cases where identical projects costing millions of dollars were being executed simultaneously by as many as three different government departments. In Barbados, a common saying describes this type of situation: "The left hand don't know what the right hand is doing."

Legislation

There is a close link between training, public education, and legislation. Poorly drafted legislation relative to biodiversity has over the years caused more harm than good to biological communities in Barbados. Assuming our trained personnel are able to attract enough public support, then it would be much easier to demand appropriate legislation. Presently, legislation in Barbados for biological protection includes:

1. The Cultivation of Tree Act. This Act provides for tax refunds to any landowner growing trees (not considered to be fruit trees as defined under this Act) on .02 ha (2,000 sq. m) or more.
2. The Tree (preservation) Act. This Act prohibits any person from felling any tree having a girth larger than one metre at breast height, unless prior permission is granted by the appropriate authority.
3. Town and Country Planning Act. This permits the Chief Town Planner to prohibit any willful destruction of trees and to direct the necessary replanting should trees be indiscriminately felled without his or her permission.
4. Soil Conservation Act. This Act is restricted to the boundaries of the Scotland District, giving the Chief Agricultural Officer the power to forbid any kind of action that may contribute to soil erosion within the district, including removal of trees, shrubs, grasses *etc.* from fragile areas; over grazing on erosion-prone land; and physical development in critical areas.

5. Wild Birds Protection Act. This Act makes it an offense to kill, wound, or trade wild birds. The Act, however, does not provide for the establishment of wildlife sanctuaries, nor does it protect the birds' habitat.

In addition to legislation, Barbados has also signed the following conventions: Convention on International Trade in Endangered Species of Flora and Fauna (March 1995), Convention on Biodiversity (December 1993), and Convention to Combat Desertification (1997).

Finally, Barbados is updating its species list and making the necessary recommendations for their protection. In addition, an Environmental Management and Land Use Plan is being developed to recommend establishment of national parks and protected areas as a method of conservation and preservation.

CONCLUSION

In concluding, therefore, let me reiterate that critical needs, such as training, public education, legislation, and, last but not least, inter- and intra-institutional communication, must be addressed urgently.

LITERATURE CITED

Ligon, R. 1657. A true and exact history of the island of Barbados. Rome

BIODIVERSITY IN CUBA

Vladimir Moreno

The Cuban territory occupies approximately 111,000 km^2 and it comprises the Main Island, the Isle of Youth, and 4,195 keys. The Cuban sea shelf covers about 68,000 km^2. Cuba has the greatest biodiversity in the West Indies and many of her scientific values are still to be preserved, many of her species are still to be discovered, and some of her areas are not yet completely explored.

Knowledge of biodiversity in Cuba is still incomplete, although vascular plants and some fauna groups have been fairly well studied (table 1).

Table 1. - Plant and animal endemism in territorial Cuba.

Taxonomic group	Known species	Endemics	%
Plantae			
Bryophytas	921	78	8.47
Pteridophytas	500	53	10.6
Gimnospermae	20	13	65.00
Angiospermae	6,500	3,409	52.44
Annimalia			
Nematododa	278	79	28.42
Anelida	35	15	42.86
Plathyelminthes	176	64	36.36
Mollusca	1,468	1,381	94.07
Crustacea	200	12	6.00
Chilopoda	43	26	60.5
Diplopoda	83	78	93.98
Insecta	7,493	2,299	30.68
Arachnida	1,302	677	51.99
Pisces	57	23	40.35
Amphibia	46	43	93.4
Reptilia	121	91	75.2
Aves	350	22	6.28
Mammalia	38	15	39.47
Totals	**19,631**	**8,378**	**42.68**

Vascular plants comprise about 6,140 species, grouped into 1,300 genera and 181 families (Moreno and Leiva 1997). More than half the species are endemic (Borhidi and Muñiz 1983) and more than 870 plant species are rare and threatened (IUCN 1989).

The composition of the present Cuban natural vegetation has been conditioned mainly by the island's geographic location, relief, complex geology, soil diversity, and geographic isolation. These factors have also influenced the level of vegetation endemism, which tends to increase in gradients towards mountainous areas. In these areas, the environment changes drastically within short distances but there have been no remarkable climatic changes for long periods of time, factors favoring the species-building process. In non-mountainous areas, endemism is rare, usually coinciding with soils originating from serpentine rock, coastal semiarid land strips, white sand (siliceous) plains in the western country, and karstic formations that sometimes appear also as part of the main mountain ranges.

CUBAN FORESTS

Tropical rain forests, serpentine xeromorphic shrubs, white (silica) sand savannas, and the karstic vegetation complex are some of the most interesting Cuban forest formations due to their endemism and rich biodiversity. Semideciduous forests, pine woods, and mangrove forests also stand out because of their occurrence throughout the national territory. About 18% of the Cuban territory is mountainous and most of the biodiversity is concentrated on these steep surfaces, with about 75% of endemism just in the vascular flora. Most forests are located in these mountains and in the lower littoral areas, including keys and islets.

According to the National Center of Biodiversity (CENBIO 1995), the Cuban forests are divided, according to the territorial principle, into the following categories: national parks 5.9%, recreation 1.7%, natural reserve 8.7%, protection and conservation of flora and fauna 20.2%, protection of water and soils 16.4%, protection of littoral zones 17.7%, and production 29.4%. The Cuban forest covers approximately 3 million ha, 90% of which belong to the Ministry of Agriculture. About 70% of the Cuban forests are devoted to protection and conservation; the rest are production forests. Approximately 500 tree species comprise the Cuban flora, 200 of which are considered important wood producers; this number has greatly increased in recent decades due to the introduction of fast-growing, exotic species preferred for reforestation.

Like most countries in this region, Cuba has greatly reduced its forest resources in the last two centuries, as can be observed in table 2. During the first half of this century, some attempts were made to stop forest destruction, *e.g.*, the promulgation of the Forest Law in 1945. But the effort had no government support, so it achieved poor results. In 1959, serious efforts were begun to reforest the country; the diminishing of forest areas was checked and an increase in forest coverage was begun. In order to achieve all this, an intensive reforestation program was implemented that today is called the "Turquino-Manatee Plan" and encompasses the whole country. During recent years, forest area has increased 30,000-70,000 ha per year under programs intended to protect natural forests. Studies indicate that the country should strive for a forest cover of at least 28% of the total area.

BIODIVERSITY MANAGEMENT IN CUBAN FORESTS

The main management activities undertaken in Cuba have been reforestation and silvicultural treatment in natural forests and plantations. As an economic activity, silviculture does not benefit forest biodiversity since it generally tends to reduce the number of species, eliminate strata, and reduce the frequency of individuals per age and size. The cutting of natural, mixed forests is common in our country in order to establish monospecific plantations. Generally this practice seriously impairs biodiversity; but it has sometimes been beneficial when it has been done to reduce the pressure to produce wood on well-preserved natural forests. The ongoing National Environment and Development Program strives to diminish harm to biodiversity through the use of more species in plantations, especially native species.

Management for biodiversity conservation in the Cuban forests has been carried out in three main ways:

1. *In situ* conservation normally carried out through management of protective forests as well as conservation forests. This task is mainly the responsibility of the State's Forest Service of the Ministry of Agriculture, the Forest Guard Body of the Ministry of the Interior, and the Environment Management and Auditing Center of the Ministry of Science, Technology, and Environment. The objective is to protect the forest heritage and biodiversity, by achieving what has been proposed in the Project on Forest Ordering. In the past two years, the value of

Table 2. - Changes in Cuban forest cover, 1812 – 1995.

Year	1812	1900	1959	1990	1995
% of territory covered by forests	89.2	54.0	14.0	19.5	21.0

watersheds as units for conservation work has been recognized. Watershed commissions at national and local levels were created for this purpose.

2. *In situ* conservation carried out through the National System of Protected Areas. This includes 88 areas of national significance and 201 areas of local significance. The main authorities dealing with protected-area establishment, management, and control are the Ministry of Science, Technology, and Environment with the National Center of Protected Areas, and the Ministry of Agriculture with the Forest Division, and the National Enterprise for the Protection of Flora and Fauna (Perera 1997). This way, more than 11% of the national territory has been protected to the extent possible in each of the management categories. The protected territories are those where most Cuban biodiversity is concentrated.
3. *Ex situ* conservation carried out through the network of Cuban Botanic Gardens. The National Botanic Garden includes representative species of the main forest formations in its field collections. In addition, more than 70 species (Moreno and Leiva 1997) other than those listed on the Red List of Rare and Threatened Plants (IUCN 1989) have been reported.

Research has contributed greatly to biodiversity management in Cuban forests by strengthening the three related programs mentioned above. Although much forest research has been done in our country, the following studies bear directly on biodiversity conservation in forests:

1. A study on flora and vegetation has been under way for several centuries but has become more intense in the present century, when it was possible to study the main ecosystems in our country.
2. The development of genetic improvement programs for the most important tree species from the wood-production viewpoint. On the one hand, these studies have yielded positive results because many more productive genotypes have been produced through selection methods; on the other hand, this work has negatively impacted biodiversity as genetic variation has been reduced for the individuals selected to build forests.
3. The study and rescue of native tree species (more than 100 in Cuba) that were in a critical conservation condition in nature has produced propagation techniques for more than a dozen of these plants, so it has been possible both to establish them in *in situ* collections in botanic gardens and include them in reforestation plans.
4. The introduction and management of valuable, fast-growing, exotic species have been intensively studied during the past 3 decades. The use of these species greatly increases plantation productivity, although biodiversity is reduced because native plants are replaced by others alien to the site. Moreover, the use of certain soil-preparation techniques severely damages the ecosystem and the native vegetation.

LITERATURE CITED

Borhidi, A. and O. Muñiz. 1983. Catálogo de plantas Cubanas amenazadas o extinguidas. Editorial Academia. La Habana, Cuba. 85 p.

CENBIO. 1995. Estudio nacional sobre la biodiversidad en la república de Cuba. Programa de las Naciones Unidas para el Medio Ambiente. Centro Nacional de Biodiversidad (CENBIO). La Habana, Cuba. 451 p.

IUCN. 1989. Rare and threatened plants of Cuba. *Ex situ* conservation in botanic gardens. The IUCN Botanic Gardens Secretariat. E.A. Leadley and P.S. Wise Jackson (compilers and editors). Kew, Surrey. 37 p.

Moreno, V. and A.T. Leiva. 1997. Plantas raras y amenazadas de Cuba en el Jardín Botánico Nacional. Plumería 5: 18-24 .

Perera, A. 1997. Cuba. Pages 27 – 29 in C. Yocum and A.E. Lugo, editors. Protected areas management. Proceedings of the eighth meeting of Caribbean Foresters at Grenada. Puerto Rico Conservation Foundation and the International Institute of Tropical Forestry/USDA Forest Service, Rio Piedras, Puerto Rico.

BIODIVERSITY IN DOMINICA

Arlington James and Jacqueline Andre

INTRODUCTION

Dominica is situated at 61°25'W longitude and 15°25'N latitude, in the inner arc of islands forming the Lesser Antilles. It is mainly of volcanic origin, with a few outcrops of coral limestone on the west coast. The island is the largest of the Windward Islands and the Organisation of East Caribbean States (OECS). It has an area of 289.8 sq. miles (751 km^2), a coastline measuring 91 miles (146.5 km) long and is oriented in a north-south direction. Dominica's population of 73,393 (1996 estimates) is mostly of African origin, but includes descendants of Carib Indians, who occupy the 3,782-acre (1,531-ha) Carib Territory on the island's east coast.

Geology and Topography

The geology of Dominica is similar to that of the other volcanic islands in the Caribbean. The island's topography is characterized by rugged, steep terrain with many narrow rivers and deep gorges. Gently sloping land is restricted to the coastal areas in the northeast and the centre of the island. A chain of eight mountains extends from north to south, with the highest point being the summit of Morne Diablotin at 4,747ft (1,447 m) elevation. The peaks of all the island's major mountains are less than 4.3 miles (7 km) from the sea. Dominica has numerous rivers and streams, which are inhabited by several species of freshwater fish, shrimps and crabs, and two species of molluscs.

Climate

Dominica's climate is classified as humid tropical marine. It is characterized by little seasonal and diurnal variation in temperature, and strong, steady trade winds blowing generally in a westward direction (Caribbean Conservation Association *et al.* 1991). The island has been described as the wettest in the Caribbean, with 80% of the land area receiving 98 inches (2,500 mm) or more rainfall annually. Rainfall in some of the central regions reaches 394 inches (10,000 mm), dropping off to 47 inches (1,200 mm) in rain-shadow areas along the west coast. The island experiences an annual dry season usually from January to June and a rainy season from July to December, although unseasonal heavy downpours during the dry season are not uncommon. Like for most other Eastern Caribbean islands, tropical storms and hurricanes are the main weather feature affecting Dominica, and over the last two centuries the island has been hit by almost two dozen hurricanes (Evans & James 1997a).

The Economy

Dominica's economy is heavily dependent upon agriculture, with bananas as the dominant export crop. Other crops, such as coconuts, citrus, and root crops, are included in the island's agricultural diversification drive. The contribution of tourism to the island's economy has been increasing, with much emphasis being placed on cruise tourism as well as eco-tourism. Persons from the rural and urban areas alike utilize the products of the forests (*e.g.* timber, wild meat, and medicinal plants), while the local craft industry depends upon a steady supply of raw materials from the island's forests.

DOMINICA'S BIODIVERSITY

Dominica is popularly referred to as "The Nature Island of the Caribbean," with a wide variety of natural attractions, substantial natural vegetation cover, and rich and varied flora and fauna. Several wild plants have traditionally been harvested for food, others for use as medicines or spices, and still others for producing dyes and crafts. Hunting for wild meat (birds, mammals, crustaceans, fish, amphibians, and reptiles) is still widely practiced throughout the island.

Terrestrial Habitats

The topography of Dominica, combined with its varied range in altitude and high precipitation, has

resulted in a variety of vegetation types on the island. The undisturbed forests are the most extensive in the Lesser Antilles, while its rain forests are considered to be the finest in the insular Caribbean (Caribbean Conservation Association *et al.* 1991). Almost two-thirds of the island is still covered by some form of natural vegetation (table 1), but over the last decade and a half the country lost about 10% of its forest cover, particularly rain forest, due to agricultural expansion.

Table 1. - Dominica's main vegetation types by area (Prins 1987).

Vegetarian type	1984 area (ha)	% of total area
Mature rain forest	24,490	31.0
Montane rain forest	3,640	4.6
Secondary rain forest	9,090	11.5
Montane thicket	800	1.0
Elfin woodland	170	0.3
Littoral woodland	140	0.2
Scrub woodland	6,240	7.9
Semi-evergreen forest	7,170	9.1

Other vegetation types on the island occurring in smaller amounts include wetlands (montane swamps, coastal freshwater swamps, and small upland and coastal marshes), riverine and estuarine vegetation, savannah and grassland, fumarole vegetation, and palm brake. In addition, Dominica has several natural ponds, two freshwater lakes (and a boiling lake), forest plantations, numerous gardens, and agricultural plantations (*e.g.* coconut, citrus, banana), which add diversity to the habitats available on the island.

Dominica's flora has been described as "most similar to that of the nearby French islands, Guadeloupe and Martinique" (Nicholson 1991). Dominica's native flora includes over 1,000 species of flowering plants (Caribbean Conservation Association *et al.* 1991). One hundred and ninety-five species of ferns and fern allies grouped in 51 genera and 10 families have been recorded for the island. Only 1 native conifer *Podocarpus coriacea* has been recorded, while 186 species of monocotyledons in 138 genera and 21 families occur on the island. Seventy-four native species of orchids have also been recorded. Nicholson (1991) lists 53 indigenous species of higher plants that are either endemic only to Dominica, or are two-island or three-island regional endemics that are also found on Martinique and/or Guadeloupe. He also noted that little information about endemics among the mosses, algae, fungi, lichens, liverworts, and hornworts on Dominica is available. At least 11 species of higher plants are endemic to Dominica alone (Lack *et al.* 1997).

Fauna

Dominica has a varied fauna and is host to the most diverse assemblage of wildlife remaining in the smaller Eastern Caribbean islands (Caribbean Conservation Association *et al.* 1991). Birds, bats, reptiles, and freshwater fish are particularly well represented on the island. To date, 175 species of birds have been recorded on Dominica (Evans and James 1997b), including 2 endemic species of Amazon parrots - *Amazona imperialis* and *A. arausiaca*, and 27 species of seabirds; 60 of the island's bird species are resident breeders. The island's macrofauna (table 2) includes 31 species of terrestrial crustaceans (including freshwater species), 14 species of terrestrial reptiles, 4 species of amphibians, and 15 species of mammals.

Although there are no extensive coral reefs around Dominica, there are several patch reefs and deep reefs that contain a variety of corals, tropical fish, sponges, and other marine invertebrates. Almost 20 species of cetaceans have been recorded off Dominica's coast, providing excellent opportunities for whale and dolphin watching. Four species of marine turtles have been identified in the waters off the island, although only three nest on the island's sandy beaches.

Table 2. - Selected groups of macrofauna from Dominica.

Faunal group	Number of species
Birds	175
Crabs (terrestrial and coastal)	20
Freshwater shrimp	11
Bats	12
Other mammals	3
Lizards	9*
Amphibians (frogs)	4
Snakes	4
Marine turtles	4
Butterflies	55
Moths (large species)	116
Millipedes	6
Centipedes	3
Scorpions	2
Freshwater fish	8
Whales	14
Dolphins	5

*One additional species of lizard *Gymnopthalmus underwoodi* to be confirmed for Dominica

Although several invertebrate studies have been conducted in Dominica, *e.g.* during the Bredin-Archbold-Smithsonian Expedition to Dominica of 1964-1968, the full extent of the diversity among Dominica's invertebrates has not been fully established. Twelve species or sub-species of macrofauna found on Dominica are endemic to the island. These include species of bat, birds, lizards, snakes, frogs, and butterflies.

MANAGEMENT OF DOMINICA'S BIODIVERSITY

Two government agencies in Dominica are responsible for managing the island's biodiversity. The Forestry and Wildlife Division, which was established almost half a century ago, manages and pro-tects the island's forests and terrestrial and freshwater fauna. The Division also shares responsibility for management and protection of marine turtles with the Fisheries Development Division, which manages the State's marine resources. Dominica's terrestrial and freshwater fauna has been placed in two broad classes: game species and protected species. Separate licenses are required to hunt for game (*e.g.* crabs, opossum, agouti, frogs, and selected birds) and fresh-water fish and shrimp during the 6-month open season, which extends from September through February.

Legislation

The management and protection of the island's wild fauna is covered under the Forestry and Wildlife Act (1976) as well as under the National Parks and Protected Areas Act (1975). The Forestry and Wildlife Division is also responsible for controlling and managing the harvesting of forest products (timber, vines, reeds, flowers, *etc*) from the State's forest reserves and unallocated State land (formerly called Crown Lands). The permit and licensing system is administered under the Forests Act of 1958. Legislation for the protection of the Dominica's biodiversity was first enacted almost 100 years ago with the passage in 1902 of the Mongoose Ordinance, 47 years before the establishment of the Forest Service.

Protected Areas

Dominica currently has five legally established terrestrial protected areas: two forest reserves, two national parks (fig. 1), and one protected forest. The parks and forest reserves cover about 20% of the island's area. A marine reserve was recently established in the south of the island and several other areas have been proposed for inclusion in Dominica's national park and forest reserve system.

IMPORTANCE OF DOMINICA'S BIODIVERSITY

The diversity of ecosystems and species in Dominica has contributed immensely to the island's "Nature Island" image in the Caribbean. The island's rich flora and fauna are regularly touted in tourism promotion for the island in an attempt to attract eco-tourists, bird-watchers, and other nature-oriented visitors. As a result, tourism arrivals have been increasing.

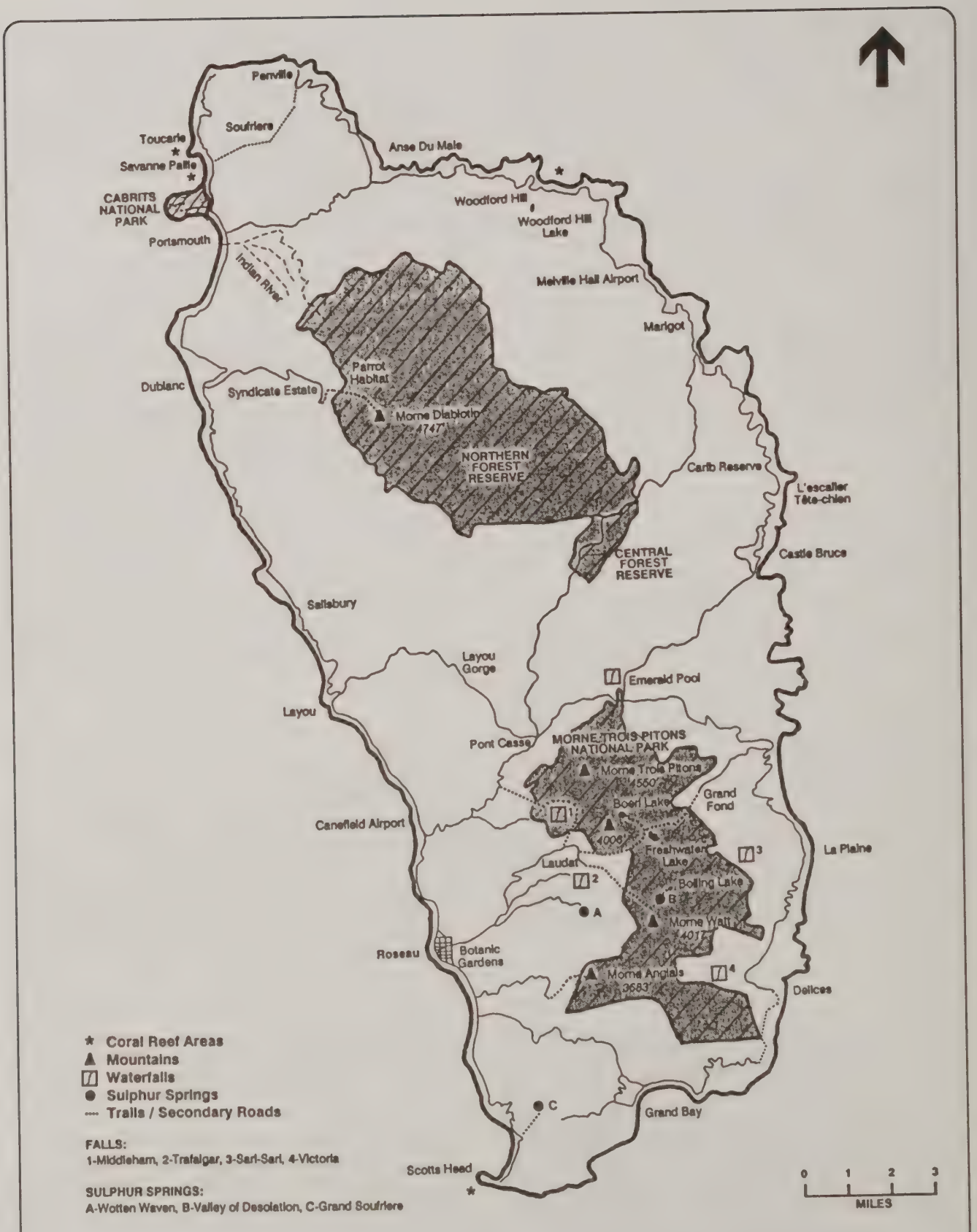


Figure 1. - The parks, reserves, trails and natural attractions of Dominica (source: Division of Forestry and Wildlife, GOCD).

In December 1997, Dominica's Morne Trois Pitons National Park was enlisted by UNESCO as a World Heritage Site (Natural Area Category). The species and habitat diversity of the park greatly influenced the acceptance of the park's nomination for world heritage site status.

Dominica's indigenous people, the Carib Indians, regularly harvest the "Larouman" reed (*Ischnopsiphon arouma*) and Roseau reed (*Gynerium sagitata*) - dye-producing plant parts, leaves, seeds, vines, and tree roots for the production of traditional and modern craft items. This helps preserve the island's cultural heritage as well as providing income for those persons involved in the activity.

Local folk medicine is still widely practiced in Dominica; Adjanohoun *et al.* (1985) described 166 species of plants that are used in local medicines on the island. The products or parts of at least four species of wild fauna (boa constrictor, a small land crab, and two lizards) are also used in folk medicine.

Some of the island's terrestrial and freshwater species (*e.g.* crabs, birds, frogs, mammals, fish, and crayfish) also serve as a source of protein for the population and a source of income for some persons from rural and urban areas alike who sell all or part of their catch. Tree barks, such as mauby, cinnamon, and "bois bandé" (*Richeria grandis*), wild leafy vegetables, wild yam, and wild fruits are regularly harvested. The harvesting of bay *(Pimenta racemosa)* leaves also supports the local bay oil industry in some rural areas, while the sale of some of the other products/items subsidizes the incomes of several persons from the rural districts (James and Gallion 1996).

CONCLUSION

Dominica's Forestry and Wildlife Division has been a key player in the management and protection of the island's biodiversity through its environmental education and awareness programme, as well as through the enforcement of forestry, wildlife, and national parks legislation. The biodiversity of the island will continue to play an important role in the island's cultural heritage, in meeting the protein needs of the rural and urban population, and in sustaining the local craft industry as well as in maintaining the island's "Nature Island" image, which, in turn, will continue to attract nature-oriented tourists. However, much work remains to be done in terms of identifying and documenting the extent of the island's biodiversity, particularly among the lower plants and small invertebrates. Investigations also need to be conducted on popularly used and under-utilized species of plants and animals to determine their full potential for pharmaceutical and insecticidal use. The results of such investigations could bring long-term benefits to the island and its citizens.

LITERATURE CITED AND BIBLIOGRAPHY

Adjanohoun, E., L. Ake Assi, P. Chibon, S. Cuffy, J.J. Damault, M.J. Edwards, C. Etienne, J. Eyme, E. Goudote, J. Jeremie, A. Keita, J.L. Longuefosse, J. Portecop, A. Soopramanien, and J. Trojan. 1985. Médecine traditionelle et pharmacopee. Contribution aux études ethnobotaniques et floristiques à la Dominique (Commonwealth of Dominica). Agence de Cooperation Culturelle et Technique, Paris.

Caribbean Conservation Association, Island Resources Foundation and YES Committee. 1991. Dominica environmental profile. Caribbean Conservation Association, St. Michael, Barbados.

Chase, F. and H. Hobbs Jr. 1969. The freshwater and terrestrial decapod crustaceans of the West Indies, with special reference to Dominica. Bulletin, Smithsonian Institution, United States Natural History Museum, 292: 1-258.

Dominica Statistical Office. Pers comm.

Evans, P.G.H. and A. James. 1997a. Dominica nature island of the Caribbean: A guide to geology, climate and habitats. Ministry of Tourism, Dominica. 28 p.

Evans, P.G.H. and A. James. 1997b. Dominica nature island of the Caribbean: Wildlife checklists. Ministry of Tourism, Dominica. 48 p.

James, A. and A.C. Gallion. 1996. The utilization of non-wood forest products in Dominica. Caribbean Journal of Agriculture and Natural Resources (CAJANAR) Vol. 1, No. 2: 4-13.

James, A. 1996. Non-wood forest products used in handicraft production in Dominica. The OECS Forester: A handbook of forests in the Eastern Caribbean. OECS Natural Resources Management Unit: 31-34.

Lack, A.J., C. Whiteford, P.G.H. Evans, and A. James. 1997. Dominica nature island of the Caribbean: Illustrated flora. Ministry of Tourism, Dominica. 88 p.

Nicholson, D.N., R.A. Defilipps, A.C. Nicholson, and Others. 1991. Flora of Dominica, Part 2: Dicotyledoneae. Smithsonian Institution Press, Washington, D.C. 274 p.

Prins, P. S. 1987. Commonwealth of Dominica forestry policy and administration: 1989 – 1997. Natural Resources and Rural Development Project. Organisation of American States, Washington, D.C.

Swank, W.G. and C.R. Julien. 1975. Distribution and status of wildlife in Dominica. Food and Agriculture Organisation of the United Nations, Rome.

BIODIVERSITY IN THE DOMINICAN REPUBLIC

Mamerto Valerio, Alberto Sánchez and S. Escarraman

INTRODUCTION

The Dominican Republic occupies the eastern 2/3 of the Hispaniola Island, which is shared with Haiti. The country is 48,448 km^2 in area with a population of more than 8 million people spread throughout 120 small towns. The biggest city is Santo Domingo with around 3 million people.

Physiographically, there are five mountain chains running parallel from east to west, with fertile valleys between. The highest elevation of the Caribbean is located in the Dominican Republic, known as Pico Duarte, rising 3,175 m above sea level.

We have great diversity in ecosystems and environmental conditions. The Trade winds from the northeast influence the rains. Precipitation varies from less than 450 mm/year near Enriquillo Lake to more than 4,000 mm/year in the Casabito Mountains. The mean annual temperature is 26° but temperatures range from less than 0°C in the highest mountains to more than 40°C at sea level. As a result of this wide range in climatic conditions the Dominican Republic comprises 16 different life zones divided mainly between the subtropical humid forest (60% of the forest area) and subtropical dry forest (20%). The humid forest is located in the northeast and mountainous zones, while the dry forest occupies the southwest lowlands and the northwest flatland region.

FLORAL AND FAUNAL BIODIVERSITY

There are 5,600 species of flora known in the Dominican Republic of which 36% are endemic: 5,000 species are seed-bearing and 600 are ferns *etc.* About 29% of the country has some kind of forest cover, including coniferous forest, 6%; broadleaf forest, 13%; dry forest, 8%; and mangrove forest, 2%.

The fauna of the Dominican Republic shows great diversity. About 800 species and subspecies of vertebrates have been identified. Of the 70 species of fishes known, 22 are native and 25 are endemic; of the 60 amphibious species, 58 are endemic; of the 141 reptile species, 117 and 22 are endemic and natives, respectively. Of the 254 bird species known, 22 are endemic, 104 are native, while 118 are migrant. Of the 33 species present, 4 are endemic, 17 are native, and 12 are introduced.

FORESTRY AND AGROFORESTRY ACTIONS

Focusing on biodiversity during the last 15 years, the DR government has been involved in forestry and agroforestry programs. Reforestation, agroforestry, and community forestry activities have been widely implemented in the country. Species used in reforestation programs include 16 fast-growing, exotic species and 14 native trees. Interest in timber production has grown among small land holders, private owners, and commercial enterprises. Economic biodiversity, and protection of the environment have guided the reforestation programs.

The implementation of a reforestation program, known as Promotion of Native Woody Species, sponsored by the Small Grants Programs (GEF – UNDP – PRONATURA) and executed by the NGOs Enda Caribe, SODIN, FUNDEMAFA, FUNDASUR, INDECO, and FUNEPROCUNIPA, has greatly influenced the use of native forest trees for timber production in association with small farm agricultural production in various places.

ENTITIES PROMOTING FOREST BIODIVERSITY

Biodiversity in DR is promoted and implemented by government, non-government organizations, and private owners.

Government

The DR government has assumed an important role in the development of forestry and the protection of our biodiversity. Since 1988 new policies have been implemented to promote forestry development and watershed protection and to motivate the population to get involved.

Today, our forestry service is involved in planning and monitoring such activities as seed production, nursery management and forest management and protection. It has established legal procedures for commercial reforestation, delimiting protected areas, and authorizing the marketing of forest products. The following government institutions are taking the lead in forestry management in the Dominican Republic: CONATEF (Technical Forestry Commission), PNQV (National Plan of Reforestation "Quisqueya Verde"), DGF (Forestry General Direction), and SURENA (Sub-Secretary of Natural Resources). All these institutions will soon be incorporated into a new Ministry of Natural Resources.

Non-Government Organizations (NGOs)

NGOs have played an important role in fostering the interest of the rural population in biodiversity as well as in agroforestry and forestry activities. Small farmers' organizations participate in planning, executing, and monitoring these and other development activities. More than 200 local and international NGOs work in the environment and protected areas.

Private Sector

In our opinion, increasing biodiversity in the environment is only possible by developing a viable private forestry sector. Production forestry (timber harvesting, sawmilling and marketing) on a big scale will help ensure the sustainability and conservation of the natural forests. Forestry policies in the country are moving to support this. A guideline for small holders and enterprises has been made to help them make better economic and environmental decisions.

BIBLIOGRAPHY

Anonomous. 1991. Informe nacional: Conferencia Mundial de las Naciones Unidas sobre el Medio Ambiente y Desarrollo. Santo Domingo, R.D. 186 p.

SEA/SURENA/DVS. 1990. La diversidad biológica en la Republica Dominicana. Santo Domingo, R.D. 266 p.

SEA/SURENA/DVS. 1998. Inventario del uso y cobertura de la tierra en Republica Dominicana. Santo Domingo, R.D. (unpublished).

BIODIVERSITY IN GRENADA

Augustus Thomas and Jocelyn Paul

BACKGROUND

Grenada, the smallest and most southerly of the Windward Islands, consists of three main islands: Grenada (312 sq. km), Carriacou (34 sq. km), and Petit Martinique (2.3 sq. km). The total land area is 348 sq. km, and the combined population is 95,000. Grenada has a rugged topography characterised by steep ridges and deep valleys, which dominate the interior. A single north-south ridge plus a series of radiating ridges divide the island into 71 watersheds (fig. 1). Grenada's biological diversity, demonstrated in table 1, is not as rich as that of the other Windward Islands. There are two endemic species of non-woody plants, the Grand Etang fern (*Danaea spp.*) and the cabbage palm (*Oxeodoxa oleracea*); one endemic tree (*Maythenus grenadensis*); and two endemic species of animals, the Grenada dove (*Leptotila wellsi*) and the burrowing snake (*Typhlops tasymicris*). The agouti and two species of snakes have become extinct. A number of others, including the Grenada dove, the hooked-billed kite, Euler's flycatcher, and the iguana, are threatened or endangered.

Table 1. - Summary of Grenada's biodiversity.

Resource	No. of species	Endemic
Plants	About 2,000	2
Amphibians	4	
Reptiles		
Snakes	9	1
Lizards		
Birds	150	1
Mammals		
Terrestrial	4	

The island harbours remnants of montane rain forests, elfin woodlands, palm brake, montane thicket, evergreen and semi-evergreen forests, deciduous forests, cactus scrub and littoral woodlands (fig. 2). Small pockets of mangroves form fringes along the northeastern and southern coastlines (fig. 3). The remaining natural forests are found mainly in the steep, inaccessible, agriculturally-unproductive, mountainous interior (fig. 4.) No systematic attempts have been made to monitor changes in natural forests since 1949. Area estimates of forests and woodlands are shown in table 2.

Table 2. - Natural vegetation by forest types and regions in Grenada & Carriacou.

Forest type	Area (ha)
Grenada	
Forests	3,970
Woodlands & scrub	5,270
Mangroves	190
Inland swamps	30
Carriacou	
Forests/Woodlands	242
Forest region	**Area (ha)**
Grenada	
Grand Etang	1,748
Annandale watershed	202
Concord watershed	96
Mt. St. Catherine	573
Mt. Hope Clabony	262
Levera	220
Carriacou	
High North Park (Carriacou)	242

Source: Weaver 1989.

Cloud forests, found mainly on the upper slopes of Grand Etang and Mt. St. Catherine, have suffered

Figure 1. - Major watersheds in Grenada, according to the Land Use Division (source: Francis 1986).

	Area	
	km^2	Percent
SUBCLIMAX		
Mangrove Woodland	5.3	1.7
CLIMATIC CLIMAX		
MONTANE		
Elfin Woodland	3.7	1.2
Lower Montane Rain Forest	141.1	45.2
SEASONAL		
Evergreen & Semi-evergreen Seasonal Forest	70.8	22.7
Deciduous Seasonal Forest	70.2	22.5
Coctus Scrub	10.9	3.5
DISTURBANCE CLIMAX		
Palm Brake (Hurricane Forest	10.0	3.2
	312.0	100.0

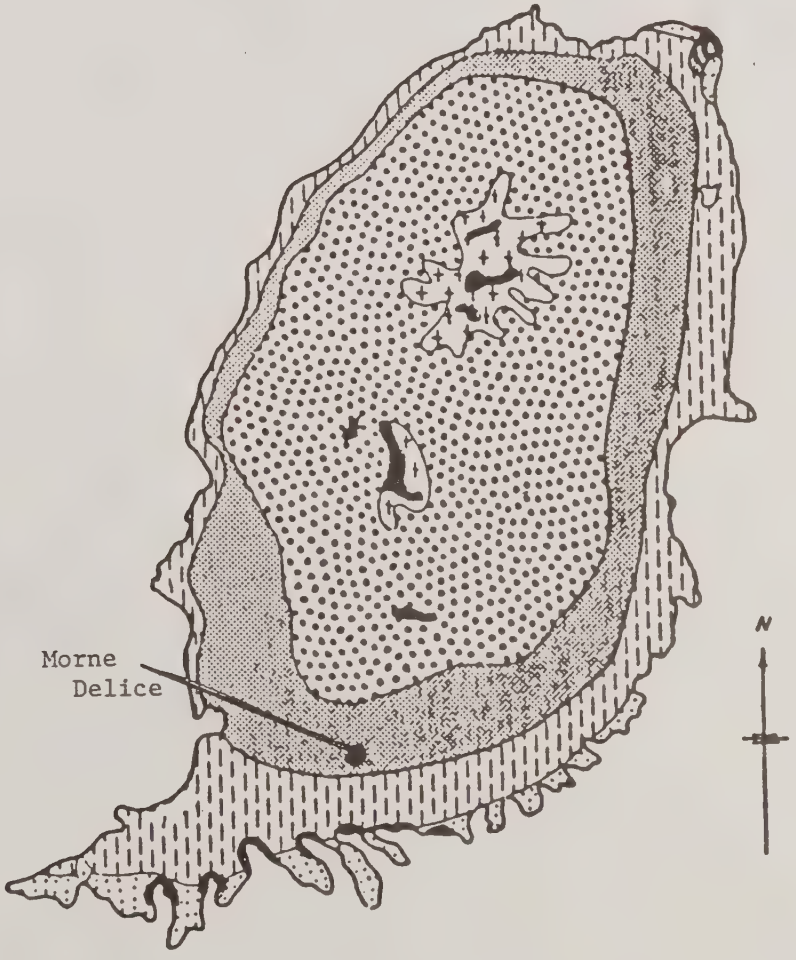


Figure 2. - Grenada's original forests (source: Weaver 1989).

No.	Name	Type	ha
01	Antoine Bay	Basin	4
02	Black Bay	Fringe	1
03	Calivigny Bay	Fringe	11
04	Cato Bay Salt Ponds	Salt Pond	3
05	Conference Bay	Basin	28
06	Content	Fr & Est.	3
07	Egmont Harbour	Fringe	15
08	Gt. River Bay South	Basin	3
09	Gt. River Mouth	Basin	2
10	Hardy Bay	Basin	2
11	La Sagesse S. Pond	Salt Pond	3
12	Levera Pond	Basin	33
13	Mt. Hartman Bay	Fringe	4
14	Perseverance	Basin	?
15	Petit Bacaye Bay	Basin	2
16	Prickly Bay	Fringe	3
17	Requin Bay	Fringe	< 1
18	St. David's Hbr.	Basin	1
19	True Blue Bay Pond	Bas. /S. Pond	1
20	Westernhall Bay	Fringe	13
21	Wharf	Fringe	2
22	Woburn Bay	Fringe	11
a 01	Caliyigny Islands	Salt Pond	1
h 01	Hog Islands	Salt Pond	2

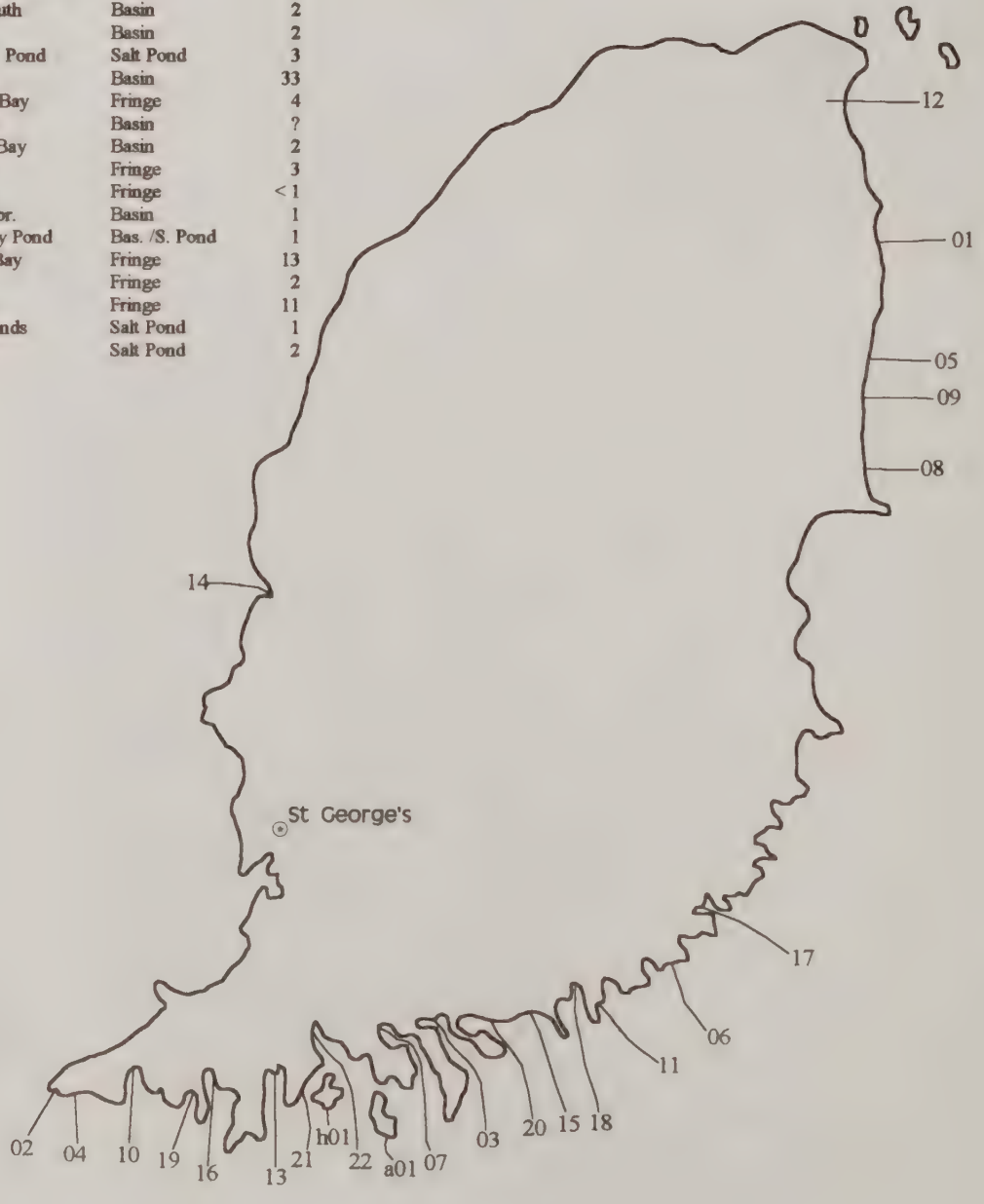


Figure 3. - Mangrove sites in Grenada (Bacon 1991). (Submitted by author, and adapted by IITF, 1999).

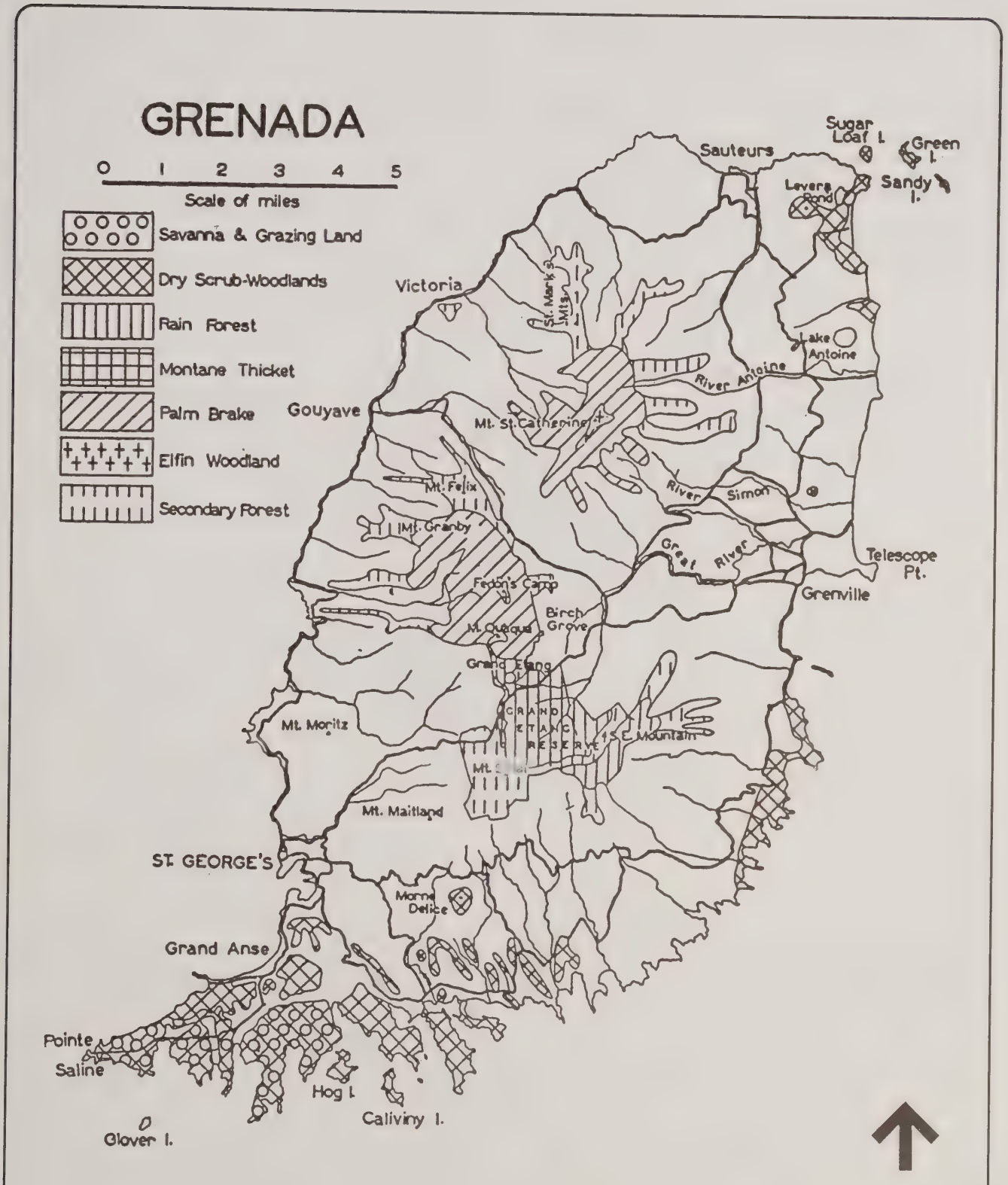


Figure 4. - Vegetation map of Grenada (source: Beard 1949).

little degradation and are presently under no serious threat. Most of the lower montane rain forest, except in the upper watershed of the Great River, has disappeared. Agricultural crops have replaced most of the forests in the middle elevations. Remnants of deciduous forests exist in the south and north. In the south, housing development is the major threat to forests, while in the north, charcoal burning and grazing threaten privately owned mangrove forests at Conference and Pearls.

PRIORITY OF PRESERVING BIOLOGICAL DIVERSITY

The Government of Grenada (GOG) recognises the importance of the island's biodiversity and places high priority on its conservation and sustainable utilization. In 1988, GOG collaborated with the Organization of American States (OAS) to produce a National Parks System Plan and subsequently enacted the National Parks and Protected Areas Act in 1990. The implementation of the plan, however, has received little or no support. In 1990, in collaboration with the Caribbean Conservation Association (CCA), the Grenada Country Environmental Profile was produced. The national bird was changed from the ramier to the Grenada dove in 1991 to encourage conservation of this endangered species.

Grenada is actively involved with the Alliance of Small Developing Island States (AOSIS) in support of the Barbados Programme of Action. The country is also a signatory to the Convention on Biological Diversity and is attempting to implement Article 6 of the Convention, which calls for participants to prepare national strategies and action plans and to integrate biodiversity planning into sectoral and other national plans. A focal point for biodiversity has been established in the Ministry of Finance. The coordination of biodiversity initiatives is the mandate of the National Sustainable Development Council. This body was established to review government policies and private-sector initiatives from a sustainable development perspective.

An Enabling Activity Proposal in Biodiversity had been developed and submitted for consideration under the Global Environmental Facility. The objective of the proposal is to formulate a strategy for the protection and sustainable use of Grenada's biodiversity and to prepare a plan of action for its implementation. The project will, among other things, seek to conduct a comprehensive assessment of existing information on Grenada's biodiversity; implement a participatory, strategic planning process; and develop priorities for action in protecting Grenada's biodiversity.

NATURAL RESOURCE LEGISLATION

The legal base for the management and conservation of Grenada's natural resources is contained in the following laws: Forests Soil and Water Conservation Ordinance 1949 and the Forests Soil and Water Conservation (Amendment) Ordinance 1984, Wild Animals and Birds (Sanctuary) Ordinance 1928, National Parks and Protected Areas Act 1990, the Grenada Fisheries Act 1989, and National Water and Sewage Authority Act 1990.

PROJECTS AND ACTIVITIES IN BIODIVERSITY CONSERVATION AND MANAGEMENT

Past land-use planning has given little consideration to the conservation and sustainable utilization of the island's biological resources. The key players directly involved in conserving and managing Grenada's biodiversity are the Forestry Department and Fisheries Division in the Ministry of Agriculture and the National Parks in the Ministry of Tourism. Management of the country's forests is shared between the Forestry Department and, in theory, the National Parks. The Forestry Department is mandated to manage the Grand Etang Forest Reserve, Morne Delice, Annandale watershed, and vegetation on Crown Lands. Several areas have been proposed as national parks (fig. 5), however some of the areas are under the jurisdiction of the Forestry Department.

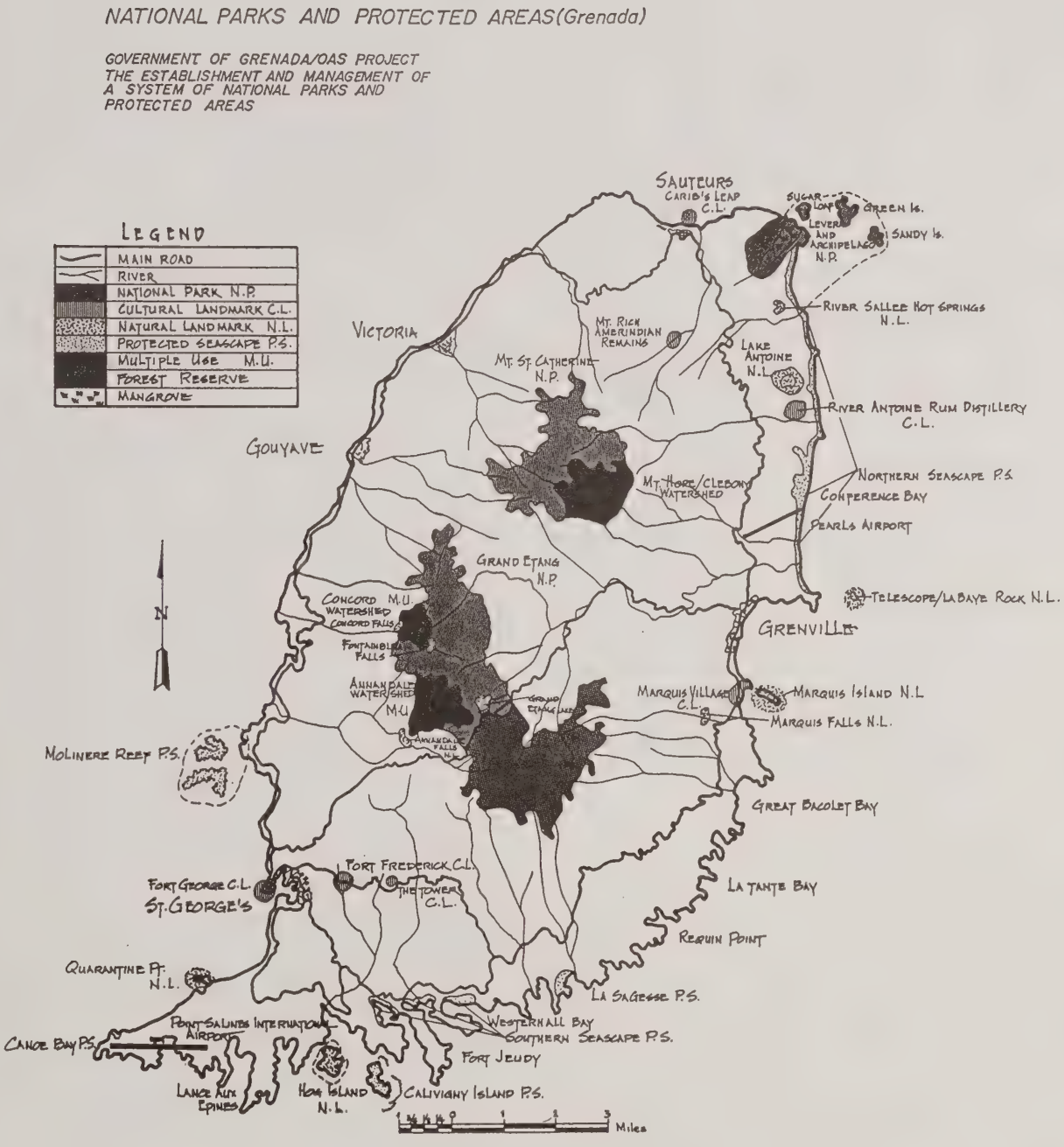


Figure 5. - National parks and protected areas.

Forest Policy Review

The Forestry Department, with support from a United Kingdom (UK)-assisted Forest Management Project, is currently reviewing and developing a new forest policy. Figure 6 outlines the various stages in the policy review process. Issues relating to biodiversity are addressed in the review.

Survey and Demarcation of Forests

To protect Grenada's remaining forests, the Mt. St. Catherine public forests, Annandale watershed, and Morne Delice forests will be surveyed, demarcated, and gazetted as forest reserves. Management plans will be developed for these areas. The survey is expected to begin soon at Morne Delice.

Morne Delice Recreation/NatureTrails Project

The Forestry Department is implementing an ecotourism project at Morne Delice forests, located in the south of the island. The main objectives of the project are to provide habitat for rare flora and fauna, recreation, and environmental education. Outputs of the project include the development of nature trails; construction of a viewing platform, a café, and refreshment shop; and production of information sheets.

Mt. Hartman National Park

The Government of Grenada has taken another step towards protecting the Grenada dove. The Mount Hartman Estate, the main habitat of the dove, has been declared a national park. One main objective of creating the park is to develop a long-term recovery programme for the dove.

Marine Protected Areas (MPAs) Project

This programme aims to (1) demarcate selected coastal areas for conservation, efficiently manage the resources, and resolve present and predictable user conflicts, (2) create the appropriate institutional arrangements that will reflect the input of all stakeholders, and (3) create greater public awareness of the use and protection of coastal resources.

Grenada began the MPAs programme in1988 when certain marine areas were identified as needing special protection. These areas include White and Saline Islands, Molinere Reef, and the Bianca C Wreck. The CCA became involved at that stage and agreed to help fund a project entitled Initiation of a System of Marine Parks in Grenada. Under this project, several activities were undertaken, including the drafting of appropriate legislation, conducting biodiversity surveys and benthic mapping at White and Saline Islands and Molinere, demarcation by GPS, and initial consulting with some stakeholders.

Creation of Artificial Reefs

The French Government is supporting three "Coral Reef Valorisation and Protection Projects" approved by Cabinet. These projects are located at Molinere/Beausejour and Woburn/Calliste.

Caribbean Planning for Adaptation to Climate Change (CPACC)

This is a 4-year project funded by the Global Environmental Facility (GEF), implemented by the World Bank, and executed by the OAS. This project is the result of an initiative taken by CARICOM States at the Small Island States (SIDS) Conference held in Barbados, April - May 1994. The objective of the project is to support Caribbean countries in preparing to cope with the adverse effects of global climate change, particularly sea-level rise in coastal and marine areas, through vulnerability assessment, adaptation planning, and capacity building. Grenada is participating in all the regional components of the project and has established a tidal gauge and weather station at the Grenada Coast Guard Site at Prickley Bay, True Blue, St. George's for monitoring sea-level rise, wind speed, precipitation, *etc*. Grenada has benefited from a number of workshops conducted by CPACC, thus strengthening participants' capabilities in this area. It is envisaged that the benefits of the project would be both global and regional, providing

Global Benefits

- long-term protection by appropriate planning for coastal and marine resources and ecosystems and international waters
- generation of information related to sea level, climate, vulnerability, and economic matters for world-wide use
- development of vulnerability assessment technologies, policy options, and a regional

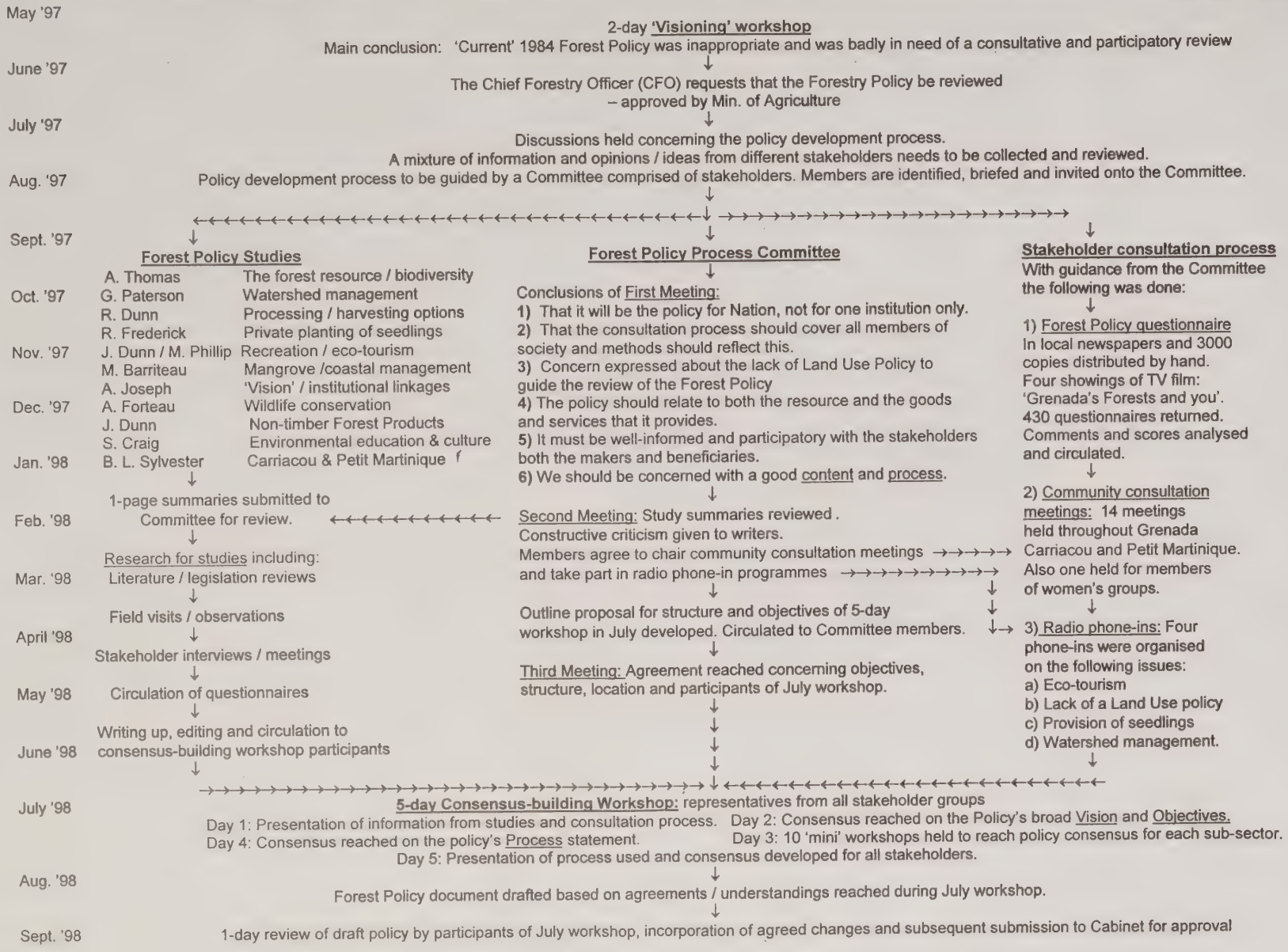


Figure 6. - Grenada's forest policy development process.

approach for dealing with Global Climate Change (GCC)

Regional Benefits

- strengthening a regional network of GCC involved institutions
- building the region's adaptation planning capability
- supporting GCC related international and intergovernmental programs in the region
- providing the basis for CARICOM member governments to agree on a regional strategy for dealing with the GCC threat

CONSTRAINTS TO BIODIVERSITY CONSERVATION AND MANAGEMENT

Biodiversity conservation and management in Grenada are affected by institutional, political, technical, and financial factors. Some of these constraints include the following:

- poor coordination within and between Government and other stakeholders,
- lack of private-sector involvement,
- lack of awareness of biodiversity and its benefits by government agencies and general public,
- lack of adequately trained personnel,
- no scientific research on biodiversity,
- lack of adequate scientific and economic data for planning and management, and
- lack of strong policy framework and political commitment.

IMPORTANCE OF BIODIVERSITY IN NATIONAL DEVELOPMENT

Grenada's biodiversity produces both tangible and intangible benefits to the Grenadian population. Some of these benefits are realised through ecotourism, employment, government revenue, foreign exchange earnings, supply of materials and consumer goods, and agricultural productivity.

LITERATURE CITED

Beard, S.J. 1949. The natural vegetation of the Windward and Leeward islands. Oxford forestry memoirs, no. 21, Clarendon Press. Oxford, UK.

Weaver, Peter L. 1989. Forestry development, Grenada: forestry planning and management activities. FO: TCP/GRN/8851. FAO, Rome, Italy: 112p.

BIODIVERSITY IN GUYANA: ITS MANAGEMENT AND BENEFITS

James Singh and Gangadai Persaud

COUNTRY PROFILE

Geographical Setting

The Cooperative Republic of Guyana is located on the northeastern coast of South America, between 57° 28' 27" and 61° 23' 24" west longitude and 01° 10' 55" and 08° 33' 22" north latitude. On the northern side it has a coastline of approximately 432 km on the Atlantic Ocean and a continental shelf of 48,665 sq. km. It is bounded by Brazil (1,208 km) to the south and southwest, by Suriname (726 km) to the east, and by Venezuela (650 km) to the west. Guyana has an area of 214,970 sq. km and a population of about 780,000. About 30 % of the population resides in urban areas, and about 90 % lives on the narrow, coastal plain. The Amerindians, or indigenous peoples of Guyana, live in the hinterland areas along with a few non-Amerindians who are engaged primarily in mining or forestry operations.

Climate

Due to its proximity to the equator, the climate is influenced predominantly by the moving Intertropical Convergence Zone. Thus, there are two wet and two dry seasons, except in the southern third of the country where there is a single rainy and a long dry season (Ramdass and Haniff 1990).

Geology

In Guyana, the geomorphological regions closely reflect the geological divisions. There are four geomorphological/geological regions:

- The Coastal Plain, which is made up of a narrow belt of land along the shoreline overlying the Corentyne group of rocks. Morphologically, there is the Old Coastal Plain and the Young Coastal Plain, which together account for 7.5 % of the country.
- The Sandy Rolling Plains or the White Sands Formation. This lies inland between the Coastal Plain and rock outcrops farther south. It occupies about 12 % of the country.
- The Pakaraima Mountain Region, which is in the mid-southwestern region of the country. Massive sandstones interbedding with conglomerates and shales of the Roraima Formation lie below. Elevated plateaus dominate this region, which constitutes about 14 % of the country.
- The Pre-Cambrian Lowland Region is gently undulating territory, generally 90 - 120 m in elevation. However, there are some peaks over 300 m high in the north, and some over 900 m in the south. It is the largest region of the country and is mostly under savannah or tropical forest.

Soils

Most of the good agricultural land is found on the coastal plain. It contains a variety of soil types including swampy soil; fortland clays-low humic gels of high and medium base status, of grey color and a mottled upper horizon and dark grey lower horizons; pegasse soil, which is mainly organic consisting of decayed vegetative matter, an acidic highly toxic soil underlain with clay; and silty clay soil with red mottles overlaying lateric soil. Ridges of loose sandy soils are present on the surface.

The white sands area has a porous sandy soil low in fertility. Some parts have regosols and latosols, which are low in nutrients. The Pakaraima region is predominated by a thin layer of lithosol derived from solid rocks. Depending on the nature of the parent rocks, the soil varies from acidic to basic and its color is also influenced by the rock type. Some lateritic soils are found on old, eroded surfaces. The rain forest landscape of the Pre-cambrian region has podzols, latosols, hard pans, and lateritic crusts. The savannah landscape has red-yellow latosols, sandy clay loam on clays and sands, sandy soils, gleyed soils, and lithosols.

Hydrology

Water resources are abundant but seasonal differences are marked, resulting in alternating periods of drought and flooding. The shore of the coastal plain is basically muddy although sand and shells are found in some areas. The Amazon River is the source of sediments along the Guyana coast. Extensive, intertidal mudflats are produced by sediments from Guyana rivers. Accretion occurs along 50 % of the coast. Most rivers flow northwards, except a few left-bank tributaries of the Essequibo that flow west to east.

Ecosystems

Three major ecosystems can be found in Guyana: coastal, savannah, and tropical forest. The coastal ecosystem includes five types of ecosystems: coastline, estuarine, riverine, palustrine, and lacustrine. Two types of savannah ecosystem are recognizable: the wet and semi-wet savannahs in the northeast (or the intermediate savannahs), and the dry savannahs in the southwest, called the Rupununi savannahs. The Tropical Forest ecosystem can be subdivided into the tropical moist forest, white sand or wallaba forest, brown sand forest, swamp forest, lower montane moist forest, and montane moist forest. These constitute the largest ecosystem in Guyana, covering 76.6 % of the land area.

BIODIVERSITY MANAGEMENT IN GUYANA

Definition of Biodiversity

According to Brown *et al.* (1993), the term biodiversity can be used "to describe the number, variety and variability of living organisms". Braatz *et al.* (1992) describe biodiversity as encompassing the variety and abundance of plants, animals, and micro-organisms as well as the ecosystems and ecological processes to which they belong. "Biodiversity is usually considered at three levels: genetic, species and, ecosystem diversity."

Significance of Biodiversity

Biodiversity provides economic benefits in the form of food, medicines, and industrial raw materials. It also serves humanity by supplying the working ingredients for natural ecosystems that provide an array of essential services. These include keeping the air clean, modifying climatic extremes, degrading wastes, recycling nutrients, creating soils, and controlling diseases. There is also an ethical and aesthetical aspect to biodiversity: plants and animals have intrinsic value independent of their monetary value; also, many species of wild plants and animals and their ecosystems are a source of spirituality and inspiration to humanity (Braatz 1992).

According to the literature (WRI 1994, Brown 1990), total numbers of species worldwide range from 3 to 30 million, of which less than 1.5 million have been named. Although most birds, mammals, and plants are already recorded, knowledge about insects and micro-organisms is scarce. Some 40-90% of the world's biodiversity is located in the tropics (WRI 1994). The Plant Press (May-June 1998), a publication of the National Museum of Natural History, Smithsonian Institution, states that of the 270,000 vascular and flowering plants worldwide, 33,798 were found to be at risk of extinction. The need for biodiversity management is therefore obvious, especially since the afore-mentioned article also states that a great many plant species known to have medicinal value are threatened and may disappear, leaving their healing potential unfulfilled.

Situation in Guyana

Until recently, there was no one organisation solely responsible for managing biodiversity in Guyana. Initial steps were taken by the government of Guyana (GoG) to establish an agency to oversee all biodiversity work but, due to financial and other constraints (such as lack of enough qualified personnel), this goal is taking some time to be realized. Nevertheless, work on biodiversity has been ongoing. Below are examples of the work being done.

The Forestry Sector

Article 36 of the Constitution of the Cooperative Republic of Guyana states that in "the interests of the present and future generations, the state will protect and make rational use of its land, mineral and water resources, as well as its fauna and flora,

and will take all appropriate measures to conserve and improve the environment". According to The Carter Center (1998), "the Government of Guyana (GoG) intends to preserve Guyana's forests through a combination of sustainable development of timber and mining resources, conservation of substantial tracts for low-impact activities and the creation of a system of National Parks and Protected Areas".

Guyana is rich in biodiversity. Approximately 169,000 sq. km of Guyana is under forest cover, more than 75 % of the land. The tropical rain forest is one of the most complex and diverse ecosystems on earth; it is a highly ordered system, linking the morphological, physiological, and ecological systems of individual members. Although a high percentage of the biodiversity in Guyana's forest is still unidentified, the forests are basically intact; Colchester (1997) estimated the annual rate of deforestation to be 0.1 %. Contributing largely to this low rate is the fact that 90 % of the population lives near the coast which has allowed most of the forests and other rich eco-systems in the south to remain intact. Also, most of the forests are virtually inaccessible and can only be exploited commercially through a large initial investment, something that is beyond the capability of the Guyanese investors.

The management of our forest resources falls within the purview of the Guyana Forestry Commission (GFC). This organisation ensures that the forest resources are managed in a manner that is beneficial to the country from an economic, social, and environmental perspective. Several forest reserves have been established, which fall within the jurisdiction of the GFC. These reserves were identified based on their species richness and research potential. One of these is the Moraballi Forest Reserve, which is extremely rich in biodiversity. A forest code of practice has been developed that provides guidelines for forest operations. This code requires all large scale investors to set aside a minimum of 5 % of the total area leased to them as a biodiversity reserve. This code is soon to be approved. For every large forest operation, a management plan has to be submitted to the GFC, and this plan's major objective must be the sustainable utilisation of the forests. It is also significant that public awareness and involvement in environmental matters are increasing, especially in the sustainable utilisation of the rain forests. The GFC also has an education arm that promotes educational programmes targeted at various sectors of society.

The GFC is presently benefitting from a project financed by the Overseas Development Administration (ODA), now known as The Department for International Development (DFID). Under this project the GoG established a three-year moratorium for new logging concessions. During this period, the GoG drew up a legislative and regulatory framework and strengthened the capacity of the GFC to monitor and administrate the forestry sector. Also during this period, Conservation International (CI) and the Smithsonian Institution (SI) undertook land-use and biodiversity surveys. These data were to be used in selecting areas for the National Protected Areas Project (NPAS). This will be dealt with in another section of this paper.

Other Biodiversity Studies Conducted up to May 1998

Many studies (inventories) have been done by several prominent researchers from recognised research institutions to document the boiodiversity of Guyana. These inventories include rapid-assessment inventories done by Conservation International on the Kanuku Mountains. Conservation International was also involved in collaborative work with SI, which will be dealt with in detail later on. Important work is also being done by Tropenbos and the University of Utrecht. The work of Tropenbos has resulted in the publication of several notable scientific publications on the biology, soil, and ecology of forests in some natural reserves and in logged forests. Tropenbos is building up an excellent, comprehensive database to provide answers to many questions about forest management. Some research topics are: ideal gap size for the regeneration of different species and forest types, ideal harvesting time in relation to seed dispersal, and ecological relationships after logging (Molinos 1995).

One of the largest logging companies operating in Guyana is the Barama Company. This company has recruited the services of the Edinburgh Centre

for Tropical Forests (ECTF) to carry out research on silviculture and harvesting practices. The GTZ has also been actively engaged in biodiversity and related work through the Natural Resources Management Project (NRMP). Basically, this project involves the use of GIS for land-use planning. The GTZ is also involved in the National Protected Areas System Project and is co-financing this project along with the GEF.

The Smithsonian Institution has been associated with biodiversity research in Guyana for decades. The Institution has sent scores of researchers to the remotest parts of Guyana on collecting expeditions to document biodiversity. Clearly, if the extent and kind of biodiversity are not known, it would be impossible to manage or protect it. With this in mind, the Smithsonian Institution, the World Wildlife Find (Canada), and the University of Guyana established in 1991 the first Centre for the Study of Biological Diversity in South America. Representative samples from all collections made on field trips are deposited at this Centre. The collections are maintained under constant conditions and are cared for by experienced curators. The Centre currently has approximately 25,000 specimens while the museum has close to 22,000 specimens. Scientists from all parts of the world work through the Centre.

The Flora of the Guianas is another important project that has gathered, collated, and analysed taxonomic information on the flora of Guyana. Apart from the taxonomic value, this information has given valuable insight to the distribution of plant types throughout the country.

The Botany project of the Treaty of Amazonian Cooperation (TAC) was also useful in data capture. Recently, a team of researchers from the University of Guyana was involved in a project entitled National Activity on the Use of Biodiversity under the TAC. Here data were collected on the flora and fauna of four sites, and patterns of use were examined to determine whether the resources were being utilised in a sustainable manner.

GEF recently funded a study to obtain biodiversity and land-use information to use in the National Protected Areas Systems. This study was undertaken by the Centre for the Study of Biological Diversity, Smithsonian Institution, and Conservation International. The most up-to-date information on biodiversity in Guyana was collected from institutions in and out of Guyana. Information was also gathered on land-use themes. In summary, the project consisted of the following considerations and conclusions:

Study Population. - Guyana has nearly 7,000 known species of plants and thousands of other organisms. To study all would not have been practical, so a sample group of organisms was selected to provide a representative picture of the country's total floral and faunal diversity. The focus organisms included 500 species from about 60 genera and included birds, mammals, frogs, termites, butterflies, *Chrysobalanaceae, Lecythidaceae,* ferns, legumes, melastomes, orchids, and sedges. Each group contained species with both widespread and restricted distribution.

Study Questions. - Biological data on these specimens were collected from museums and herbaria around the world, and the data analysed to answer the following questions: Wha is the distribution of plants and animals in Guyana? Where are the areas of species richness and endemism? How well do the data explain the biodiversity of Guyana? What areas in Guyana are in need of collection? What needs to be done to provide a clear picture of the biodiversity of Guyana?

Study Product. - A GIS program (ARC/INFO) was then used to produce distribution maps showing where collections of flora and fauna were done in Guyana. A species-richness map was also made for all sites. This map shows the total number of species present in a given area.

Study Conclusions. - The study concluded that there was need for additional information, necessitating an increase in the number of species studied per group from the original 5 % to at least 25 %. With this increase, more accurate species distribution patterns could be extrapolated for the selected group of organisms. The survey also indicated that collection sites were generally in accessible areas, while the more remote and inaccessible areas had few or no biodiversity inventories. Collection and survey of flora were also much more widespread and numerous than faunal surveys. Based on the analyses done, however, 17

areas were proposed as areas high in biodiversity and recommended as areas to be protected and conserved (CSBD 1997).

Protected Areas

Two areas in Guyana have been given protected area status: The Kaieteur National Park (KNP), and the Iwokrama International Centre for Rain Forest Conservation and Development (IICRFCD).

The KNP is governed by the KNP Act and the National Parks Commission Act. Its area is about 116 sq. km (45 sq. mi) and the act provides for the preservation of the natural scenery, fauna, and flora of the area. However, until recently, little was done to manage the park. There was no proper demarcation of the boundaries, no management plan, and no trained personnel to manage it. With the advent of the protected areas system, however, the KNP has been identified as a pilot study area and work is progressing rapidly on the issues mentioned above. The plans include expanding the park to about 580 sq. km (224 sq. mi). The unique plant communities there are fairly well inventoried. The fauna has been poorly studied, however. The Kaieteur waterfall has a sheer drop of 238 m (714 ft) and the permanently moist conditions have created a unique vegetation, including spectacular orchids and bromeliads. The golden frog is also found there.

The IICRFCD is an area of approximately 360,000 ha (900,000 acres) that was donated to the International Community for scientific research on how tropical rain forests can maintain biodiversity while supporting economic activity. Iwokrama is probably the best inventoried and documented area of Guyana in terms of biodiversity studies. A detailed faunal survey has been conducted over a 2-year period by the following research institutions: The American Museum of Natural History, Florida International University, Royal Ontario Museum, University of British Colombia, University of Missouri, St. Louis University, University of Kansas Museum of Natural History, Illinois State University, York University, Conservation International, and University of Guyana. This impressive list of experienced researchers, testifies to the quality of work done on these biodiversity studies. The subjects studied were ornithology, ichthyology, mammalogy, and herpetology. A total of 2,100 bird specimens, 1,900 mammal specimens, 2,200 amphibian and reptile specimens, and13,000 fish specimens have been collected within the reserve. To date, 120 mammal, 210 fish, 450 bird, and 120 reptile and amphibian species have been recorded, attesting to the richness in biodiversity of the IICRFCD. A series of publications is soon expected, including one on the birds of the Iwokrama forest.

The floral survey is also one of the most detailed ever undertaken in Guyana. Approximately 20,000 specimens have been collected by several researchers from and associated with the Smithsonian Institution, the consultants for this survey. These specimens are presently being identified at SI, Washington, D.C.

Finally, the researchers here embarked on an aggressive public-awareness campaign to sensitize the public to the need to conserve, protect, and sustainably utilise biodiversity. This has included the IICRFCD working directly with the indigenous communities near the reserve on aspects of biodiversity use, education, etc.

CURRENT MANAGEMENT PLANS

Environmental Protection Agency (EPA)

The EPA is currently the GoG agency responsible for all biodiversity work in Guyana. The agency was established only recently and is as yet understaffed. However, it has already prescribed measures for the protection and rational use of the biodiversity resources of Guyana. Before the establishment of the EPA, there was no fixed policy on environmental and biodiversity management. The EPA has several committees including the National Biodiversity Advisory Committee (NBAC), the National Environmental Education Advisory Committee (NEEAC), the Environmental Impact Assessment Committee (EIA), and the Wildlife Scientific Committee (soon to be formally established).

The NBAC is responsible for reviewing all proposals (local and foreign) for biodiversity research in Guyana. It has established guidelines to

(1) regulate collecting of specimens, such as limits to numbers collected, (2) ensure the use of environmentally friendly and humane collecting methods, (3) limit numbers of specimens exported, (4) ensure that no rare, endangered, or threatened species are collected or exported, and (5) ensure that a local counterpart accompanies foreign researchers. All developmental work within the country now has to be approved by the EPA. An Environmental Impact Assessment has to be done by a recognised group of consultants and their report approved or rejected by the EIA committee. In this way, the EPA ensures that no significant threat to biodiversity is posed by any developmental work.

The NEEAC is responsible for educating the public on matters of the environment and biodiversity protection. It carries out many outreach programs targeted to various audiences. These programmes by making use of audio-visual equipment, have been extremely successful in sensitizing the general public, especially students.

The Wildlife Unit, which deals with the export of live wild and exotic animals, has now been transferred to the EPA. This unit has a Scientific Committee that is looking at all aspects of the export trade, *e.g.* the species that can be traded, the quotas, inspection of animals, setting trapping seasons in accordance with nesting and breeding seasons, etc. To facilitate rational decisions, this committee is planning field surveys to determine the relative abundance of species and their populations. Presently, the fauna of Guyana is in dire need of the study that this process will provide. The committee is also investigating reports of widespread poaching of some protected species by expatriates.

The EPA is working to upgrade its staff through short courses, assignments to various agencies etc. Once the agency becomes fully operational, it is expected that the biodiversity of Guyana will be better protected. Legislation is already in place to punish offenders.

National Protected Areas Project (NPAS)

This project has been in the pipeline for many years, but only recently has it been funded by the GoG. It is certainly the most important link in the chain to preserve and manage Guyana's biodiversity. The GEF and the GTZ have granted the GoG the sum of US $ 6,000,000 and US $ 3,800,000, respectively over a 6-year period to finance the NPAS project. The objectives of this project are to (1) assist the GoG in establishing a representative system of protected areas that conserve globally important biodiversity, (2) create a system dedicated to ecosystem and biodiversity conservation, watershed protection, and maintaining the country's cultural heritage, all within Guyana's strategy for sustainable development, and (3) collect information, to identify and demarcate the protected areas.

The project will include the following components: design of the NPAS, identification and selection of the protected areas, establishment of Pilot Protected Areas, institutional strengthening and training, legislative policy and long-term financial growth, and monitoring and evaluation. One area has already been identified as a Pilot Area, the Kaieteur National Park. From the experience gained there, Guyana will move to establish other areas. Several possible sites have already been suggested, based on the biodiversity richness and/or the presence of endangered species, such as the leatherback turtles, harpy eagle, giant river otter, and arapaima.

The NPAS project is still in its infancy but it is hoped that the first pilot site will be established in 1999. Then there will be a centralised systematic collection of data. This would complement all earlier data collections and lead to the establishment of a comprehensive database of Guyana's biodiversity. Our biodiversity can then be effectively managed. This would be a great leap foward, although it must be mentioned again that, due to the low population pressure on the rain forest, most of Guyana's biodiversity is still intact. As attested by most researchers who visit Guyana.

BENEFITS OF BIODIVERSITY

Practical value can be attributed to the biodiversity of Guyana at the levels of genetic diversity, species diversity, and community or ecosystem diversity. Genetic research is constantly

being done on rice and other crops to improve their resistance to diseases and increase their yield. Gene banks have been established for a variety of crops and tissue-culture research is being conducted at the National Agricultural Research Institute (NARI).

Species diversity provides Guyana with a wide range of wild and domestic plant, fish, and animal products. These are utilised for food, medicines, cosmetics, industrial products, fuel, and building materials. The indigenous people for years have depended on the forest for food, shelter, furniture, culture, decorations, medicine. Their traditional knowledge of the forest is incredible and many ethnobotanical studies have depended on them as the primary source of information.

Ecosystem or community diversity plays an important role in the cycling of water and gas, the work of mycorrhizal fungi and soil fauna in making nutrients available to plants (important in maintaining food and forage production), recreational opportunities minimising soil erosion sedimentation in water courses, stabilising the climate, and maintaining such ecological processes as productivity, hydrology, and soil generation.

CONCLUSION

Before the advent of the EPA, biodiversity in Guyana was not as closely monitored as it is now. However, many agencies/institutions were engaged in biodiversity research, and this, coupled with low population pressure, ensured that most of our biodiversity remained intact and that data were being gathered. The establishment of the Environmental Protection Agency and the introduction of the National Protected Areas System have been positive steps. Any irregularities that may have existed before are now much reduced or non-existent. The combined effort of EPA and NPAS and the growing public concern over the need for rational and sustainable use of our biodiversity all but guarantee the protection of Guyana's biodiversity in the future.

LITERATURE CITED AND BIBLIOGRAPHY

Braatz, S. 1992. Conserving biological diversity: A strategy for protected areas in the Asia-Pacific Region. Technical paper 193. The World Bank, Washington, D.C. 65 p.

Brown, K., D. Pearce, C. Perrings, and T. Swanson. 1993. Economics and the conservation of global biological diversity. Working paper No. 2. The Global Environmental Facility, W.D.C.

Brown, L., C. Flavin, and S. Postel. State of the world (1990). Norton and Co., N.Y. 253 p.

Carter Center. 1998. The proposed Guyana rain forest foundation (Concept paper). Carter Center. 7 p.

Colchester, M. 1997. Guyana fragile frontier. Unpublished.

Centre for the Study of Biological Diversity (CSBD), Conservation International, and the Smithsonian Institution. 1997. Biodiversity and land use information for the Guyana national protected areas system study. (Consultancy report). CSBD, U.G., Guyana. 23 p.

Molinos, V. 1995. Considerations for the development of Guyana's wood industry. (Consultancy report). Guyana. 64 p. Unpublished.

Smithsonian Institution National Museum of Natural History. 1998. The Plant Press (bulletin May-June). Washington, D.C. 6 p.

Ramdass, I., and M. Haniff. 1990. Priority areas for conservation in Amazonia. Guyana country paper. 47p.

WRI. 1994. A guide to the global environment. Oxford Univ. Press. N.Y. 147-164.

World Bank. 1992. Development and the environment. Oxford Univ. Press. 308 p.

BIODIVERSITY IN HAITI: ITS MANAGEMENT AND BENEFITS

Dalberg Claude, Ronald Toussaint and Jean Pierre-Louis Ogé

STATUS AND TREND

Haiti shares the island of Hispaniola in the Caribbean Sea with the Dominican Republic. Its surface is 27,750 sq. km. It comprises one third of the island and has 1,535 km of coastline. The environmental situation in Haiti is critical. Poverty and rapid popu-lation growth combine to put pressure on the natural resources. The scale of degradation is enormous. The mountainous nature of the landscape greatly favors erosion once the vegetative cover has been removed.

Holdridge (1972) differentiated nine life zones (table 1). Today these zones appear very different from those described by Holdridge in 1972. As a result of the vegetation cover lost, many species disappeared or became threatened. The Ministry of Agriculture in 1984 listed 40 species of plants and 50 species of animals in need of protection (tables 2 and 3). However, in spite of this situation, the country still boasts a valuable biological diversity. There are more than 5,000 species of vascular plants (with an endemic rate of 36 percent), about 600 species of ferns and 300 kinds of orchids plus more than 2,000 species of fauna (with an endemic rate of 75 percent). The population of endemic reptiles is large, with some harmless boas and snakes. A colony of 450 American crocodiles (*Crocodylus acutus)* lives in Etang Saumatre, a brackish lake. About 49 species of frogs have been reported on the island of Hispaniola. Twenty of them are to be found in the Massif de la Hotte, a mountain range in the southern part of Haiti. In addition, there are various butterflies,

Table 1. - Life zone classification.

Life zone	Characteristic	Vegetation
1) Subtropical thorn woodland	Semi desert, 550 mm of rainfall	Xerophytic forest: *Prosopis juliflora*, cacti,
2) Subtropical dry forest	Altitude below 400 masl, deep soil, irrigation available	*Phyllostylon brasiliensis, Guaicum officinalis,*
3) Subtropical moist forest	Alluvial plain	*Swietenia mahogani Catalpa longissima, Roystenia regia*
4) Subtropical wet forest	Low altitude mountain ridges, small mountains	Coffee, cocoa
5) Subtropical rain forest	In the southern peninsula, lower altitude of massif de la hotte	
6) Subtropical lower montane moist forest	Low altitude mountain ranging from 800 to 2,000 masl	Cultivation of potatoes and other vegetables
7) Subtropical lower montane wet forest	High rainfall	Remnants of Haiti pine forest
8) Subtropical lower montane rain forest	Limited area, slope of the higher mountain range	Pine forest, evergreen Broadleaf forest
9) Subtropical montane wet forest	Limited area, slope of the higher mountain range	Pine forest, evergreen broadleaf forest

Table 2. - List of vegetation threatened and in need of protection.

Common French name	Family name	Scientific name
Abricotier	Guttiferae	*Mammea americana*
Acajou, noix d' acajou	Anarcadiaceae	*Anacardium occidentale*
Acajou	Meliaceae	*Swietania mahogani*
Bois campeche	Leguminosae	*Hematoxyllum campechianum*
Bois capab	Rhamanaceae	*Colubrina arborescens*
Bois chandelle	Rutaceae	*Amyris balsamifera*
Bois pin	Pinaceae	*Pinus occidentalis*
Blimblin	Oxalidaceae	*Averrhoa bilimbi*
Cachiman la Chine	Annonaceae	*Annona cherimolia*
Caimite	Sapotaceae	*Chrysophyllum caimito*
Cedre	Meliaceae	*Cedrela odorata*
Cirouelle	Anacardiaceae	*Spondias purpurea*
Chene	Bignoniacaea	*Catalpa longissima*
Dalemarie	Gutttiferae	*Callophyllum calaba*
Divi-divi	Leguminosae	*Caesalpinio coriaria*
Ebene	Boraginaceae	*Rochefortia acanthophora*
Fromagier	Bombacaceae	*Bombax tussacii*
Gaiac	Zygophyllaceae	*Guaiacum officinale*
Grain ouary	Leguminosea	*Canavalia obtusifolia*
Ilan-ilan	Annonaceae	*Cananga odorata*
Jaune d'oeuf	Sapotaceae	*Lucuma domingensis*
Latanier chapeau	Palmae	*Sabal causiarum*
Mancenillier	Anacardiaceae	*Metopium toxiferum*
Macoutouca	Palmae	*Euterpe globosa*
Pomme zombi	Euphorbiaceae	*Hippomane mancenilla*
Mangle, paletuvier	Combretaceae	*Conocarpus erectus*
Manglier blanc	Combretaceae	*Laguncularia racemosa*
Manglier rouge	Rhizophoraceae	*Rhizophora mangle*
Manglier petites feuilles/ paletuvier	Sapindaceae	*Dodonaea viscosa*
Mapou	Bombacaceae	*Ceiba pentandra*
Mapou zombi, baobab	Bombacaceae	*Andosonia digita*
Palme coyeau	Palmae	*Coccothrinax argenteae*
Catie	Palmae	*Pseudophoenix vinifera*
Palmiste	Palmaea	*Roystonia regia*
Pomme cythere	Anacardiaceae	*Spondias cytherea*
Raisin de mer	Polygonacea	*Coccoloba uvifera*
Romarin	Euphorbiacea	*Croton linearis*
Roucou, roucouyier	Bixaceae	*Bixa orellana*
Sapotille marron	Sapotaceae	*Manilkara albescens*
Tavernon	Leguminosae	*Lysiloma latisliqua*
Zicaque, icaquier	Rosaceae	*Chrysobalanus icaco*

Source: MARNDR cited by USAID 1986.

Table 3. - List of animals threathened and in need of protection.

Local name	English name	Scientific name
Mammals		
Lamantin	West Indies manatee	*Trichechus manatus*
Zagouti	Agouti	*Plagiondontia aedium*
Nez long	N/A	*Solenodon paradoxus*
N/A	West Indies shrew	*Nesophantes**
Reptiles		
Caiman, crocodile	American crocodile	*Crocodylus acutus*
Tortue de mer	Sea turtle	*Dermochyeys coriacea*
N/A	N/A	*Chrysemys decorata*
Iguane	Iguana	Cyclura cornuta cornuta
Couleuvre (boa)	Boa	*Epicrates subflavus*
Birds		
Malfini, Petit malfini, emouchet	Sharp-shinned hawk	*Accipiter striatus*
N/A		
Malfini, gros malfini	Peregrine falcon	*Falco peregrinus*
Malfini savane	West Indies red tail hawk	*Buteo jamaicensis*
Gris-gris	Ridway's hawk	*Rupornis ridgwayi*
Ramier, millet, ceniza, ramier ceniza	Sparrow hawk	*Falco sparverius*
Ramier	Plain pigeon	*Columba inornata*
Jacquot	Red necked pigeon	*Columba squamosa*
Perruche, perniche	Hispaniolan parrot	*Amazona ventralis*
Maitre bois, chuet - bwa	Hispaniolan parakeet	*Aratinga chloroptera*
Ouanga neguesse	Hispaniolan stygian owl	*Asio stygius*
	Hispaniolan emmerald hummingbird	*Chlorostilbon swainsonii*
Hirondelle noire, gros martinet noir	Black swift	*Cypseloides niger*
Pie de montagne, calecon rouge		
Colibri morne, chicorette	Hispaniolan trogan	*Temnotrogon roseigaster*
Charpentier camelle, charpentier bois	Narrow-billed tody	*Todus angustirorostris*
Chitte sara	Antillean piculet	*Nesoctites micromegas*
Oiseau de la pluie, jolle-jolle		
Ouette ouette noir, merle	Greater antillean elaenia	*Elaenia fallax*
Musicien, oiseau musicien	Golden swallow	*Kalochelidon euchrysea*
Petit chitte, quatre yeux	La Selle trush	*Turdus swalesi*
Petit chitte	Rufous-throated solitaire	*Myadestes genibarbis*
Louis d'or, perruche	White -winged warbler	*Xenoligea montana*
Mounedele	Ground warbler	*Microligea palustris*
Cornichon	Blue hooded euphonia	*Euphonia musica*
Petit serein	Stripe-headed tanager	*Spindalis zena*
Bec croise	Chat tanager	*Calyptophilus frugivorus*
Petrel a coiffe noire	Antillean skin	*Carduelis dominicensis*
Aigrette, crabier blanc, quock blanc	White-winged crossbill	*Loxia leucoptera*

Table 3. - cont'd

Local name	English name	Scientific name
Cailles	Black-capped petrel	*Pterodroma hasitata*
Faisan	Great egret	*Egretta alba*
Flamand rose	Common bob-white	*Colinus virginianus*
Heron	Wood irbis, wood stork	*Mycteria americana*
Crabier, valet de caiman	Flamingo	*Phoenicopterus ruber*
Crabier, cracra	Crabier tricouloured	*Hydranassa tricolor ruficolis*
Crabier, crabier bleu, crabier noir, quock, quock blanc	Little green heron West Indian green heron	*Butorides virescens vires* *Butorides virescens maculutus*
Crabier, coq d' eau, coq de nuit Crabier de bois	Little blue heron	*Florida caerulea caerulescens*
	Black crowned night heron	*Nycticorax nycticorax hoactili*
Perdrix rouge (male), perdrix noire (female)	Yellow crowned night heron	*Nyctanassa violacea violecea*
Perdrix grise	Ruddy quail dove	
N/A		*Geotrygon montana*
	Keywest quail	
	Antillean wood duck	*Geotrygon chrysia* *Aix sponsa*

Source: MARNDR cited by USAID 1986.

mollusks, and more than 220 species of birds, of which 20 are endemic. Mammals are poorly represented. Only two endemic species survived extinction: the *Plagiodontia aedium* locally called zagouti, a nocturnal rodent, and *Solenodon paradoxus* or nez long, a nocturnal insectivore. Both of them are now endangered. Occasionally, the *Trichecus manatus*, a large sea cow, is found.

The many ecological niches that result from the variability of the topography, precipitation, and temperature explain the biological diversity. However, it is seriously threatened as the population continues to grow, forests disappear (even in remote areas), and farming is done on steep slopes not suited for tilling. Today it is estimated that forest cover is only about 2 percent. All this contributes to habitat loss, a major threat to wildlife. Because of the scarcity of inventories, it is difficult to quantify the real trend of biodiversity in Haiti. However, the authors agree that many species of plants and animals face extinction if nothing is done to halt the habitat destruction.

The introduction of exotic species is another threat to biological diversity. For example, the mongoose was introduced to control native boas. This reduced the boa population, but mongooses also eat chicken and many other birds. Many exotic plants have also been introduced, such as *Eucalyptus* spp., *Acacia* spp., *and Azadirachta indica (*neem), but their effect on local species has not yet been investigated.

BIODIVERSITY MANAGEMENT

Legal Framework

Although recognized as an important national concern by the government, biodiversity is not protected by law. National legislation deals only with some issues linked to biodiversity, such as forests and protected areas. Critical issues such as equitable sharing of benefits from the use of genetic resources and intellectual property rights, are not yet taken into consideration.

Legislation establishing protected areas was initiated in Haiti in the early 1900's. Examples include the February law of 1926 on National Forest Reserves and the Orders of April 1926, October 1937, and March 1947 creating other reserves. A National System of Protected Areas (SPNA) made of reserves, protected areas, national sites, and natural national parks was established, at least on paper. The current Haitian Constitution, adopted in 1987, recognizes biodiversity by requiring the government to appraise the value of natural sites, protect fauna and flora, and create and maintain zoological and botanical gardens. Existing legislation however is not appropriate for current realities. The flora and fauna are not treated as a whole system and traditional rights of local people are ignored. There is a strong need to revise the laws to reflect current thought.

Haiti has ratified some international treaties relating to biodiversity management. The Convention for the Protection of the World Natural and Cultural Patrimony (1972), the Convention on Climatic Changes, the United Nations (UN) Convention Against Desertification, and the UN Convention on Biological Diversity (CBD), signed at Rio Earth Summit and ratified on August 20, 1996, are examples. Haiti is also party to some regional treaties such as the Convention for the Protection of Flora, Fauna and Natural Panoramic Beauties of Countries in America (1940), and the Convention to Protect the Artistical, Historical and Archeological Patrimony of American nations (1976).

In spite of these efforts the country still needs to integrate other international and regional efforts dealing with biodiversity management. Among them, the Ramsar Convention, the Convention on International Trade of Threatened Wildlife Species (CITES), The International Convention on Tropical Wood (1983), and the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region.

INSTITUTIONAL FRAMEWORK

Conservation and management of biological diversity are the responsibility of several ministries and agencies in the country. The National Environmental Council, created in the context of the National Environmental Action Plan (NEAP), coordinates environmental policies, plans, and programs for the public sector. The Council, headed by the Prime Minister, consists of the Ministers of Environment, Agriculture, National Planning, Public Health, and Engineering Public Works. The Ministry of Agriculture, Natural Resources, and Rural Development (MARNDR) is charged with raising the productivity of agriculture and fisheries through efficient use of the nation's natural resources. This Ministry has at least five agencies dealing with biodiversity issues:

The Centre de Recherche et de Documentation Agricole deals with the protection and management of phytogenetic resources, a key element of biodiversity. The Fisheries Service is responsible for overall management and protection of fisheries and related matters. The Natural Sites and Park Service and the Forests Resources Service under the MARNDR are responsible for the administration and management of parks and forests. The National Institute of Agrarian Reform, a semi autonomous agency under MARNDR jurisdiction, is charged with monitoring and supervising activities on land rented by the State, and land tenure planning.

The Ministry of Environment (MOE), created in January 1995, addresses several environmental issues. Its main functions are making policy for the environment and renewable natural resources, drafting legislation and regulations for natural resource management, and educating people on environmental issues. In a working paper distributed by the former government, the MOE was made responsible for monitoring and supervising national parks and other protected areas. This Ministry

oversees the international environmental treaties ratified by the country. Its organizational structure includes the Biodiversity Service, which is not yet completely operational. Other institutions involved in biodiversity management in Haiti, are the Ministry of Planning (responsible for the territorial planning and management), and the Ministry of Culture (through the Institut du Sauvegarde du Patrimoine National).

MANAGERIAL AND TECHNICAL APPROACHES

The Haitian government, through the Forests and Parks Protection Project, is seeking to decentralize the management of biodiversity. The goal is to establish national alliances among government, communities, and private entities to promote the conservation and management of biodiversity and biological resources. In doing so, the government recognizes that participation of different stakeholders is critical to the success of conservation initiatives. Even if decentralization can place biodiversity at risk, effort is being made to establish a new balance of power in the management of natural resources.

New mechanisms for regional dialogue, planning, and conflict resolution have been established through the creation of three Consultative Councils at the Macaya and La Visite National Parks and the National Forest Reserve of Foret des Pins. These councils consist of farmer representatives, parliament bodies, police, local governments, non-governmental organizations, *etc.* This is the first step toward effective co-management of resources with local people. At the same time, a citizen group, derived from a national workshop on biodiversity management and financial issues - the Groupe d'Initiative de Xaragua (GIX) - is working at the national level to support a system of national protected areas and a Biodiversity Conservation Trust Fund.

The government is also establishing task forces to facilitate national planning and action and to foster cross-border cooperation in the field of biodiversity with the Dominican Republic (DR). The Ministries of Agriculture and Environment are currently cooperating to create a National Commission on Phytogenetic Resources dedicated to preparing a national action plan for sustainable use of phytogenetic resources. A framework for a bi-national strategy to conserve and manage Hispaniola biodiversity has also been prepared in collaboration with DR government representatives.

On a purely technical level, management is mainly centered on *in situ* conservation measures applied to two national parks (Macaya and La Visite) and the Foret des Pins National Reserve. The approach gradually integrates conservation practices and "biodiversity spirit" into the management of forests by focusing on non-timber products (medicinal plants) and favoring native species over introduced ones in forest regeneration.

Benefit Sharing

Benefits arising from the use of genetic resources in Haiti are not evident. The potential of these resources is not sufficiently known because of lack of research. In general, medicinal plants are popular in the country. Case studies are needed to better assess the use of wildlife made by local people.

GAPS AND CONSTRAINTS

To effectively manage biodiversity, the country needs to fill the following gaps:

- *Lack of legal framework to determine access to genetic resources and recognize intellectual property rights.* This issue is not sufficiently understood or taken into consideration in current efforts to revise national legislation.
- *Lack of a strong commitment of the non-governmental organizations (NGOs) to conservation causes.* Biodiversity is not a subject that mobilizes Haitian NGOs. Most of them need to better understand the process of sustainable development and its relation to good practices for managing biodiversity. This is a serious limitation to decentralization.
- *The confusing roles among several institutions involved in biodiversity.* Without a strong commitment of the government, the newly

established Ministry of Environment, will not be effective in coordinating the management of biodiversity.

- *The failure to integrate biodiversity concerns into non-environmental sectors.* Other ministries should integrate biodiversity concerns into their plans and conduct environmental evaluation assessments to monitor programmes, or activities likely to have adverse impacts on biodiversity.
- *Poor financial support for managing biodiversity.* Lack of funds hampered the efforts of Haiti to successfully implement the CBD. Simplifying the procedures to get funding through the Global Environmental Facility (GEF) is a complicated task.

PROSPECTS

Prospects for conserving Haiti's biodiversity in the future include the following:

- *Toward establishing a new institutional and policy framework for biodiversity conservation.* Documents establishing the legal, institutional, and fiscal reforms related to biodiversity issues exist already under the initiative of the Forests and Parks Protection Project. Work should shortly begin on the preparation of a biodiversity national action and strategy plan under the framework of an enabling biodiversity project funded by the GEF. This project represents a step forward in planning the use and conservation of biodiversity and proposing a framework of actions in the long and medium terms for enhancing biological resources.
- *Toward establishing a trust fund to conserve and manage Haiti's biodiversity*. Three Ministries of the government - Environment, Agriculture, and Finances - are jointly supporting a 3-year effort to set up a trust fund for managing biodiversity. A concept paper and strategy defining the important steps needed to realize this goal have already been completed. The Forests and Parks Protection Project will be responsible for implementing this project.

BIBLIOGRAPHY AND REFERENCES

Ehrlich, M., F. Conway, N. Adrien, , F. LeBeau, L. Lewis, H. Lauwerysen, I. Lowenthal, Y. Mayda, P. Paryski, G. Smucker, J. Talbot, and E. Wilcox. 1986. Haiti country environmental profile, a field study. USAID contract USAID-Ehrlich No. 521-0122-C-00-4090-00. 120 p.

MARNDR. 1998. Deuxième atelier national sur les ressources phytogénétiques.

Ministère de l'Environnement. 1997. Plan d'actions pour la gestion et la conservation de la biodiversité en Haiti. Ministère de l'Environnement 1997 - Haiti dans le dernier carré : Actes du Colloque sur la Gestion des Aires Protégées et le Financement de la Conservation de la Biodiversité en Haiti.

Ministère de l'Environnement. 1998. Profil d'un fonds fiduciaire pour la gestion de la biodiversité en Haiti et stratégie de mise en oeuvre.

Victor, J. A. 1997. Le cadre légal et institutionnel des aires protégées en Haiti in Les Actes du Colloque sur la Gestion des Aires Protégées et le financement de la conservation de la biodiversité en Haiti.

Holdridge, L.R. 1972. Life zones in Haiti. Carte: Ecologie d'Haiti.

BIODIVERSITY AND FOREST MANAGEMENT IN MARTINIQUE

Joëlle Calvez

INTRODUCTION

The vegetation in the Lesser Antilles is recent because of the relative youth of the Archipelago. The optimal state is forest except for some coastal and mountain vegetation. Biodiversity is extensive, including many trees species, epiphytic plants, mosses, and ferns. Forest vegetation is influenced by the geography and especially by precipitation. The diversity depends also on the microvariation of sites (aspect, slope, and soil). Degradation caused by human pressure and the dynamic response of vegetation to take over abandoned areas also affects the biodiversity.

BRIEF SURVEY OF BIODIVERSITY IN MARTINIQUE

Number of Species

The biodiversity of the French West Indies is described in *Préétude de faisabilité d'un conservatoire botanique national dans les Antilles françaises* by Brice Daniel (1997). The French West Indies harbor more than 3,000 species of seed-bearing plants, ferns, and mosses. Tables 1 and 2 compare this species richness with other French tropical countries. We can see that the French West Indies have a high density of plant species. Fiard (1992), a botanist, made the same remark about the native and naturalized tree species.

Endemism of the Flora

About 10% of the total flora of the French Antilles is endemic to the French Antilles or the Lesser Antilles. According to Fiard (1992), 23% of native and naturalized trees species found in Martinique are endemic to Martinique or the Lesser Antilles. Morever, of the 360 endemic taxa found in the Lesser Antilles, about 310, or 85%, can be found in the French Antilles.

Table 1. - Comparison of floral species richness among French countries/territories.

Location	Relative area (%)	Number of vascular plant species
Metropolitan France	100	4,500
Nouvelle Calédonie	3	4,200
French Guyana	15	5,000
French West Indies	0.5	2,300

The table uses the area of metropolitan France as 100 percent and expresses the area of the tropical territories as a fraction of the area of France.

Table 2. - Comparison of tree species diversity.

Location	Number trees species	Area (ha)
Martinique	396	1,100
Lesser Antilles	500	8,400
French Guyana	1,067	90,000

The Natural Areas in the French West Indies

Since 1970, an inventory of interestsing natural areas has begun in Martinique and in Guadeloupe. In 1980, a national inventory (ZNIEFF) was extended to all the French West Indies. Initiated by a local scientific committee, the inventory permits natural sites to be valued. Almost 60 ZNIEFF inventories are planned for Martinique (Diren 1994).

PROTECTION OF FLORA

About 30% of the endemic species of the French Antilles are judged to be vulnerable. Some of these vulnerable species are protected by the ministerial order of 1989: 15 species in Guadeloupe, 21 in Martinique, and 21 in the other French West Indies; for a total of 57. Of these 57 species protected by ministerial order, 17 are not endemic to the Lesser Antilles. But their protection is important in the French West Indies. For example, the gaïac, *Gaïacum officinale*, is on the list of protected species in Martinique and yet it is a common tree in the other islands.

Protection *In Situ*

The vegetation of Martinique is a good example of biodiversity of tropical ecosystems because of the various natural sites and the great number of species. The Office National des Forêts (ONF) fosters this biodiversity. Let me give you some examples. The first step to favor biodiversity is the protection *in situ.*

State Regulation for Forest Management: Initial Protection

Table 3 and figure 1, display the area and jurisdiction of protected sites in Martinique. Of the 15,500 ha managed by ONF, logging is authorized only on 2,000 ha (13 %), of which 1,600 ha are mahogany plantations. The protected area of 13,500 ha is impressive, but not all these forest sites have the same value or the same significance in terms of biodiversity, landscape, geology, or historical heritage. The state regulation for forest management provides them surveillance.

A Protection More Important: the Biological Reserve

Special protection is needed for a natural area with ecological significance. Let me describe the project of the Réserve Biologique de la Montagne Pelée. This reserve will cover 3,033 ha. The biodiversity is really important. The diversity of the vegetal formation and the ecosystems is exceptional. All life zones of the lesser Antilles are represented here, from the sea level to the summit of Montagne Pelée. Moreover, the fauna and flora are notable. Half of tree and ferns species and mosses of Martinique are represented. We can also find some primary forest, both hygrophytic and mesophytic. The fauna is richer than anywhere in Martinique. *Iguana delicatissima*, endemic to Martinique, is present on this site. Human activity will be prohibited on this entire reserve.

Protection *Ex Situ*

The Office National des Forêts protects the biodiversity with preservation *ex situ*. Indeed, the protection *in situ* is not enough to save some species because of the human pressure and the cyclones. In the case of the gaïac, *Gaiacum officinale*, which had been cut too heavily in Martinique and natural regeneration is insufficient, artificial conservation must be used. So, the ONF in 1997 made a stocklist of seed trees. This inventory had five stages: visit

Table 3. - Protected sites by area.

Site type and jurisdiction	Area (ha)
Forest territory owned by France and Martinique (managed by ONF)	9,720
Forest owned by Martinique (managed by ONF)	883
Littoral forest owned by France (managed by ONF)	3,980
Order of biotope protection	7.5
Territory of CELRL (managed by ONF)	996
Natural reserves (Managed by PNRM)	427
Natural sites inscrits	4,625
Total in Martinique	110,000

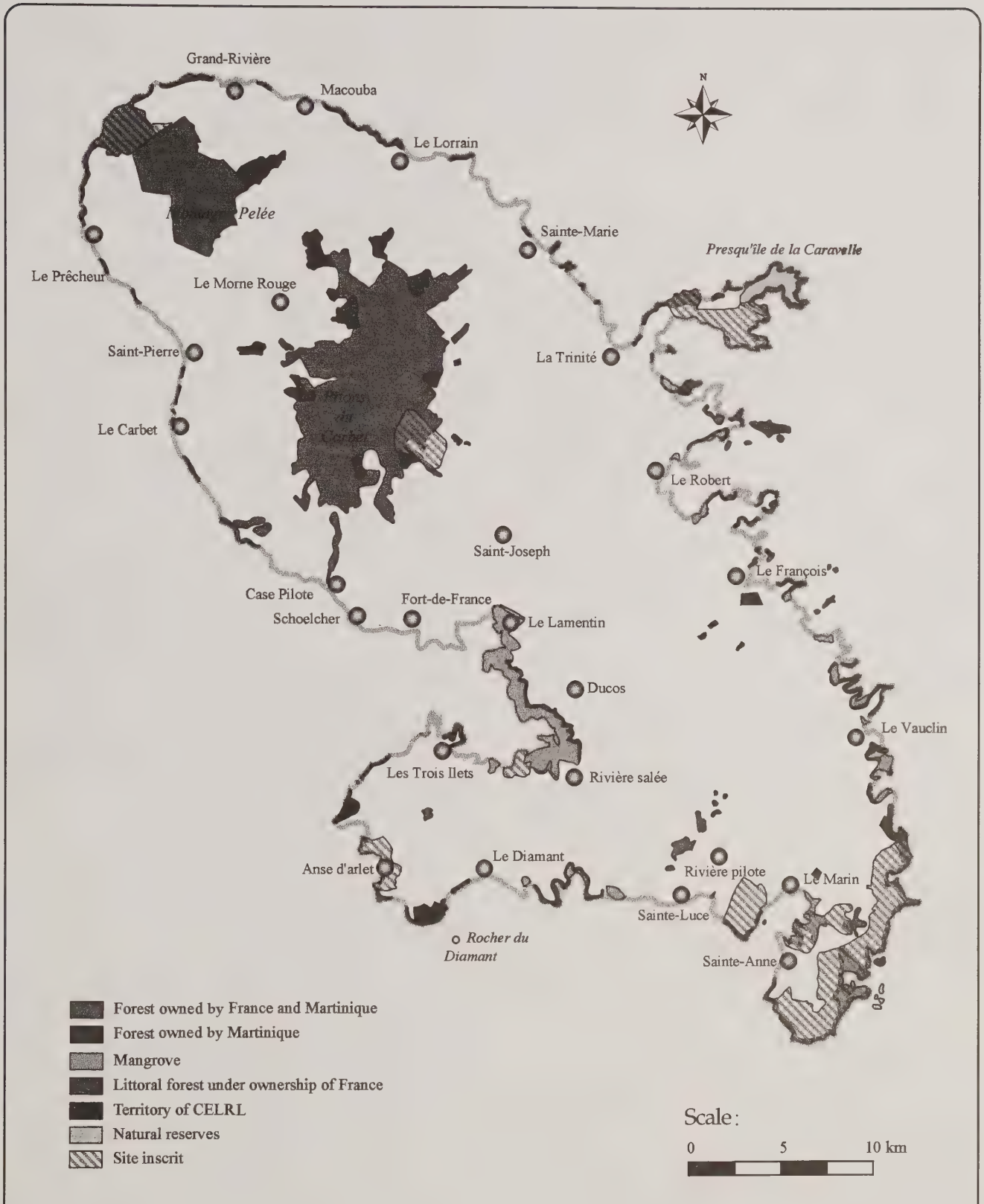


Figure 1. - Jurisdiction of protected areas.

many forests; select trees according to their accessibility, ecotype, and rarity; map the crop trees; identify each tree by a number; and develop a database (ACCESS). One hundred and eighty three species and five hundred and fifty crop trees were located.

Now, the challenge is the surveillance of the fruiting of these seed trees because of the variability of the fruiting periods. Nevertheless, seeds are collected when fruiting has been reported, and are stored in a cold room. Following this, germination tests are conducted. Most of the seeds are sowed in a nursery and later the plants are introduced into a plantation. The ONF has followed the growth of some native species in plantations (acomat, *Mastichondendron foetidissimum*; le genipa, *Genipa americana*; le poirier pays, *Tabebuia heterophylla*; le courbaril, *Hymenaea courbaril*; le bois tan, *Byrsonima cordata*; le bois de rose, *Cordia alliodora*, *etc.*). These trials are now coordinated by the technical section of ONF, based in French Guyana. This technical section was created in 1997 to answer questions asked by the forest manager. Moreover, a program of genetic amelioration of *Tabebuia heterophylla* began about 10 years ago with INRA Guadeloupe. The ONF takes part in this programme, which permits the conservation of the genetic resource of *Tabebuia heterophylla* from Caraïbes.

Conclusion

The biodiversity is protected by these actions. But it is not enough. Indeed, preservation of biodiversity *in situ* is essentially done in the public forests. But most of these are hygrophytic. So, many coastal sites and xerophytic and mesophytic areas are not preserved. As for preservation *ex situ*, the survival of some species is jeopardized because of the sparse population.

LITERATURE CITED

Direction Régionale de l'Environnement (DIREN). 1994. Inventaire du patrimoine naturel de la Martinique - Programme ZNIEFF. Société des Galeries de Géologie et de Botanique, Fort de France, Martinique, France.

Daniel, B. 1997. Préétude de faisabilité d'un conservatoire botanique national dans les Antilles Françaises – ONF. Société des Galeries de Géologie et de Botanique, Fort de France, Martinique, France.

Fiard, J.P. 1992. Arbres rares et menacées de la Martinique. Ed. Graphicom, Fort de France, Martinique, France.

BIOLOGICAL DIVERSITY IN THE FEDERATION OF ST. KITTS AND NEVIS: ITS MANAGEMENT AND BENEFITS

Bryan Farrell and Vaden Fenton

INTRODUCTION

The Federation of St. Kitts and Nevis is situated some 6 degrees south of the Tropic of Cancer, located between 17°10' and 17°25' north latitude and 62° and 63° west longitude. The Federation has a land area of 268 square km and a population of 41,600. The State of St. Kitts and Nevis gained its independence from Great Britain in September 1983 and became a political Federation.

The islands are units of an extended archipelagic clustering of oceanic islands in the Eastern Caribbean called the Lesser Antilles, which are noted for their cultural, environmental, and geological diversity. The islands are dominated by intermittently active volcanic peaks thrusting 1,152 m into the Easterly Trade Winds laden with moisture. As a result, heavy rains of up to 366 cm per year supply many regions of the islands with ample water. Rainfall over St. Kitts and Nevis is relatively plentiful. With their high central mountain ranges extending from Mt. Liamuiga at 1,156 m elevation to the peak of the South East Range at 901 m, the uplift effect produces an annual rainfall averaging 162 cm. Both islands have a tropical marine climate, heavily influenced by steady north-east trade winds, producing an environment almost ideal for human comfort. Temperature varies minimally throughout the year. The prevailing winds hold fairly steady from the east, swinging seasonally between northeast and southeast. Cloud cover unexpectedly common, averaging between 40 and 50 percent, which accounts for the low evapo-transpiration rate of around 100 cm per year (Halcrow 1966).

At 176 km^2, St. Kitts is the larger of the two islands. It is perched midway on a submerged ridge or bank some 16 km wide extending northwest to southeast from which both Nevis and the neighbouring island of St. Eustatius also arise. St. Kitts is dominated by the North West Range which includes three linked volcanoes, the largest and youngest of which is Mt. Liamuiga. The steeper part of the Central Range is surrounded by an upland forest belt blending down slope into a coastal plain sweeping gracefully to the sea. In the southeast is a narrow low-lying peninsula dominated by much older hills of sedimentary and metamorphic origin. These hills, undulating from the sea like the backbone of a mythical creature, have been greatly altered by overgrazing, logging, road construction and fire. Between the undulations of these hills lies a series of ponds of various degrees of salinity, which constitute one of the prime resources of our Federation. These low hills receive limited rainfall so the vegetational cover is a combination of savannah and fire-resistant scrub.

STATUS OF BIODIVERSITY

The present vegetation of St. Kitts and Nevis reflects great disturbance by human activity. In the lowland areas, intensive land use, especially sugar cane cultivation, has removed all vestiges of natural vegetation. However, the mountain peaks are still covered by intact virgin forests. Most lower regions of the forest are second growth on abandoned farmland that is still growing vegetables and/or ground crops such as legumes and tubers.

St. Kitts is 37% forested (Mills 1989) covering about 6,500 ha (table 1). About 80% (7,935 ha) of all land cleared for agriculture is the intensively used, mostly for mechanized sugar cane cropping. Recently, the steeper slopes, which cannot accomodate mechanized farming, have been abandoned and allowed to revert to forest or land used for grazing. As a result, the forested area of St. Kitts is no longer declining but appears to be increasing through secondary growth. Nearly all the forested areas, except the South-East Peninsula (SEP) are owned by the government. The St. Kitts

forest/woodland cover can be classified into three types:

Rain and cloud forest	2,300 ha
Moist forest	2,100 ha
Dry forest	2,100 ha
Total	6,500 ha

About 78% (or 5,000 ha) of this total is natural forest. The remaining 1,500 ha consist of either early pioneer succession or secondary growth (Prins 1987).

Table 1. - Land use in St. Kitts

Land use	Area hectares	Percent of total
Agriculture	9,886.6	56.1
Forest	6,478	36.8
Urban	1,053	6.0
Other	202	1.1
TOTAL	17,619	100.0

The principal agencies involved in land-use management include the Department of Agriculture, the St. Kitts and Sugar Manufacturing Corporation (SSMC), and the Physical Planning Unit. The pattern of land use begins with the cultivation of sugar cane from the coast line to elevations of 242 m or more. Immediately above is a transitional zone of secondary forest that contains a network of drainage basins or ghauts. Food crops are produced within this region by small farmers under rain-fed conditions. Above the transitional belt lies the natural forest extending to elevations of 1,152 m.

In Nevis, different land uses resulted in different effects on the island's biodiversity. Sugar cultivation was discontinued more than 3 decades ago; cotton cultivation also declined during the same period. The practice of raising large herds of free-ranging livestock (cattle, sheep, goats, donkeys, *etc.*) has thwarted the emergence of secondary forests; significant charcoal production for local consumption and shipment to St. Kitts also retarded secondary forest recovery. Land tenure in Nevis has been unlike that in St. Kitts; in Nevis large estates were subdivided and leased or sold as small holdings, mitigating against the better management of biodiversity evident in St. Kitts.

MANAGING FOR BIODIVERSITY

The fundamental reason for managing for diversity is simple: all life forms have some significant value, whether it be economical or ecological and whether it is realized or potential. Managing for diversity means we manage for all life forms.

Before the sugar lands were nationalized by the government in 1973, a network of sugar estates dissected the island and in most cases the forest was the unofficial boundary of these estates. These forests were considered as integral parts of the sugar plantation and their management was similar to that of the plantations in terms of conservation and utilization of forest resources. With the national acquisition of the sugar estates in 1973, these practices were drastically curtailed. The establishment of the Forestry Division within the Department of Agriculture in 1987 was viewed as a positive step towards national forestry management. An Amendment to the National Conservation and Environment Protection Act in 1996 created the Department of Environment, which assumed legislative responsibility for forestry management in the Federation. A plan to encourage the rational use and protection of forestry resources is being formulated. This National Forestry Action Plan, which is intended to strengthen forestry management, was formed, at the recommendation of the FAO/ CARICOM Tropical Forestry Action Programme (TFAP) (FAO 1992). Both islands are pursuing similar strategies.

FORESTRY AND THE ECONOMY

The full contribution of the forestry sector to the national economy of St. Kitts and Nevis is significant and broad. It touches many sectors of the

economy and most residents in one way or another, although not always in ways that are obvious (FAO 1992). The quantified contribution of the forestry sector to national output is extremely small. Based on the 1991 national accounts of the Federation, forestry contributed only EC$290,000 to the 1991 gross domestic product (GDP) of EC$386.13 million. Thus, forestry's contribution to GDP is about 1/10 of 1%. Many forest outputs are not easily measured or included in GDP. Forest outputs such as wood cut by fishermen for construction of fish traps, wood cut for clearing farm plots and used to produce charcoal *etc.*, are not measured because they do not enter formal markets. In addition, many forest outputs are not marketable. Forest output of services, such as watershed protection, erosion control, and scenery are not marketable and thus difficult to factor into GDP. In some cases, however, given physical measurements, the contributions of forestry can be valued. For example, forests in our Federation contribute to water supply by reducing run-off and flooding in the rainy season and maintaining stream flow during the dry season. Watershed management is a vital activity of forestry as most domestic and industrial water supplies are derived from surface water. The topography of the central mountain ranges has created productive watersheds that drain to the coastline. These forested fingers have traditionally been developed as sources of coarse sand for construction aggregate.

Over the last few years, tree planting has been funded by the Organization of American States, and many local, fast-growing species have been planted. No commercial plantations of wood species exist in the Federation. The topography is dominated by several species of palms.

Presently the only national park established is the Brimstone Hill Fortress National Park. This is of historic significance and caters to social and recreational forestry. Contour lines to reserve such land have not been identified, surveyed, or mapped.

Non-woody forestry products (NWFP) constitute a major proportion of resources utilized in our forests. Seeds, seed pods, leaves, bark, and roots are used by the national handicraft industry to make necklaces, curtains, baskets, chairs, *etc.* These handicraft items are important to the growing tourism industry of the Federation. Certain woody, exotic species found in the natural forest also provide wild fruits such as mangoes, plums, and guavas. These fruits support a thriving local cottage industry in exotic fruit, fruit juices, and preserves.

A wealth of general information exists on the wildlife resources of St. Kitts and Nevis (CCA 1991) but the database of wildlife information for specific localities is limited (FAO 1992). All forest zones of the central mountain ranges of St. Kitts are highly disturbed. The capacity of the fauna to survive regular human intrusions needs to be safeguarded. Other activities, including felling trees for poles and charcoal and the deliberate burning of the bark of the gummier trees, also need to be addressed.

SPECIES INTRODUCTION

Records show that species of South American origin, such as iguanas and agouti, once existed in St. Kitts and Nevis, probably brought in by Amerindians. Two species, the Indian mongoose (*Herpestes auropunctatus*) and the marine toad (*Bufo marinus*) were introduced by the British to control beetles, snakes, and frogs in canefields. The mongoose eliminated the native snakes but is thought to have destroyed native frogs, lizards, and ground nesting birds. The mongoose itself is now viewed as a major pest by farmers.

The African green monkey (*Cercopithecus Aethiops sabeus*) was reportedly introduced as a pet by the French during slavery in the 17th century. The population of monkeys has increased such that they have now become a major threat to agriculture on the islands. Large bands of these monkeys commonly ravage the sugarcane and food crops in the higher elevations.

The white tailed deer (*Odocoileus virginianus*) was introduced by the owners of Lodge Estate in St. Kitts for sport hunting. By 1931, their population had increased enough to endanger natural vegetation and agricultural crops. However, since then a combination of hunting pressure and decimation by

the tick-borne disease *Dermatocephalosis* has virtually wiped out the deer population.

Local bird enthusiasts have reported the presence of over 130 species (including migrants) on the island. Recent short-term studies have found and categorized over 70 species. It estimated that about one third of these species are migratory (Morris and Lemon 1982).

Species and ecosystem diversity are significant in the tiny land masses that comprise the Federation of St. Kitts and Nevis. Although much native vegetation may have been lost during the early colonial period, forests have rapidly regenerated over the last 100 years (Beard 1949). Native flora exists in all mountain zones and in the stony, upper reaches of most ghauts.

Information on the status of rare and endangered plants of the Federation was difficult to obtain as no detailed survey has been undertaken. Information summarized in the Country Environmental Profile of 1991 (CCA) does not specifically cover this issue. A local scientist, Dr Whittaker, surveyed the medicinal plants found in the Federation and published the results in 1997. Two local NGO's (the Nevis Historical Society and the St. Christopher Heritage Society) are undertaking biodiversity studies in the Federation as part of the United Nation Development Programme's Small Grants Project. Meanwhile, the Department of Environment is preparing to implement a National Biodiversity Strategy and Action Plan as part of the Federation's obligation under the UN Biodiversity Convention.

CONSTRAINTS AND PROBLEMS TO BIODIVERSITY MANAGEMENT

Development of forestry is hampered by the following constraints:

- absence of a comprehensive land-use plan
- inadequately trained and inexperienced staff
- misuse of land in the watersheds
- forest reserves not identified, surveyed, and legally demarcated
- uncontrolled grazing by cattle, donkeys, sheep, and goats
- little appreciation by general public of the role of forests, wildlife, and national parks
- damage to crops by feral live stock and green monkeys
- need for cooperation and coordination among agencies related to forestry management

Several problems significantly affect wildlife management in the Federation:

- Of cardinal importance is the lack of cooperation among the agencies involved in forestry management.
- No wildlife parks or reserves exist on the islands. Monkeys roam the islands at all elevations and are severe economic pests.
- Commercial development and lack of public awareness of conservation measures result in severe ecological damage.
- Lack of forestry law enforcement directly contributes to inadequate forest management.

PROSPECTS AND PROGRESS OF BIODIVERSITY MANAGEMENT

The outlook for forestry and wildlife management can be promising if the agencies become actively involved and observe and implement the Forestry Regulations encompassed in the National Conservation and Environment Protection Act (NCEPA) of 1987 and its subsequent amendment of 1996.

Morris and Lemon (1982) recommended the following steps to foster education and public awareness:

- Develop an educational programme for schools to provide information on and promote interest in the islands' wildlife.
- Produce of a series of booklets on the natural resources of St. Kitts.
- Involve interested persons in the Christmas Bird Count of the National Audubon Society to accumulate data on local breeding birds.
- Inform the general public of the need for restricted-use areas and their benefits.

Three private agencies have focused on harnessing and developing the enormous monkey population as a form of wildlife management. The Behavioral Sciences Foundation has been active studying the evolutionary biology of the monkey for the past 25 years. The St. Kitts Biomedical Foundation is utilizing the animal as an experimental tool in research. Recent work includes advanced studies of Parkinson's Disease and testing for the Acquired Immune Deficiency Syndrome (AIDS) virus. A local enterprise, Caribbean Primates Ltd., exports about 8,000 monkeys per year. These are high-quality selected animals that are used for producing vaccine by various North American pharmaceutical companies. An export levy of EC $100 per animal is received by the government. The Forestry Division is considering introducing to Greatheeds Pond, a mosquito breeding site, a selective species of fish to control the larvae (Mills 1989).

LITERATURE CITED

Beard, J.S. 1949. The natural vegetation of the Windward and Leeward Islands. Oxford forestry memoirs, No 21. Clarendon Press, Oxford.

Caribbean Conservation Association, Island Resources Foundation, St. Christopher Heritage Society and Nevis Historical and Conservation Society. 1991. Country environmental profile: St. Kitts and Nevis 277 p.

FAO. 1992. Tropical forestry action programme: CARICOM: St. Kitts and Nevis, National forestry action plan 1992-2011. 309p

Halcrow, Sir William and Partners. 1966. Report on the water resources of St. Kitts, Nevis and Anguilla and their development. Overseas Development Administration, U K.

Mills, H. 1989. Wildlife management in Saint Kitts. Pages 53 – 62 *in* A.E. Lugo and L.B. Ford, editors. Institute of Tropical Forestry and the Caribbean National Forest. Wildlife management in the Caribbean islands, Proceedings of the fourth meeting of Caribbean foresters, Río Piedras, Puerto Rico.

Morris, M. and R. Lemon. 1982. The effects of development on the avifauna of St. Kitts W. I. Department of Biology, McGill University. Montreal, Quebec.

Prins, P. 1987. St. Kitts forestry division guidelines for its development 1987-1994. Forestry development and resource planning project. Organisation of American States, Department of Regional Development. Washington D C.

BIODIVERSITY IN ST. LUCIA: ITS MANAGEMENT AND BENEFITS

Michael Andrew and Theodore Nicholas

INTRODUCTION

Location

The island of St. Lucia occupies a central position among the Windward Island group of the Lesser Antilles. Situated between 14° 05' and 13° 07' N latitude, and 60° 53' and 61° 05' W longitude. It is the second largest island of the group with an area of approximately 238 square miles (616 sq. km) and is some 27 miles (43 km) long and 13 miles (21 km) wide.

Topography

St. Lucia is volcanic in origin and hence has a mountainous topography dominated by a central, main ridge running almost the length of the island. The highest peaks occur in the southwestern portion of the island, with Mt. Gimie being the tallest at 3,117 feet (950 m) above sea level. The mountainous nature of the island has a distinct effect on the climate, hydrology, and ultimately the character of the vegetation as well as the land-use patterns. The northern and southern parts of the island are flat and geologically older than the mountainous interior, which is geological youthful.

Rainfall and Water

Saint Lucia's rainfall ranges from 60 to 150 inches (1,520 – 3,810 mm) per year, with the bulk of the rainfall occurring between May and November. Rainfall is heaviest in the interior mountains where orographic rainfall contributes significantly to the water balance. Rainfall is the main source of fresh water in St. Lucia, averaging about 35 billion gallons (132 billion liters) per year. Due to the rugged topography and the lack of sufficient storage reservoirs, most of the water flows quickly to the sea. Only a small amount is stored naturally as ground water because of the nature of the volcanic bedrock. Consequently, the timely interception of the rainfall run-off is the only means of making water available for human use, while the remainder performs its essential role in maintaining natural vegetation and rain-fed agriculture.

Land Use Pattern and Land Tenure in St. Lucia

In St. Lucia, some 35% of the total land area in natural vegetation, representing 53,760 acres (21,765 ha). Of this, some 18,526 acres (7,500 ha) is contained within the Government Forest Reserves. Of the remaining land area, 55% (84,480 acres or 34,202 ha) is farmland and 9.5% (14,592 acres or 5,908 ha) is in urban use, surface water, and exposed rock. The remaining rain forests are confined to the central Barre de L'isle from La Sorciere to the central mountains in the Soufriere area. Agricultural land virtually surrounds forested regions right down to the coast.

Analyzing the land-use patterns according to land tenure we see that approximately 94% of Government Forest Reserves is covered by rain forest and plantation forests (17,910 acres or 7251 ha). A minor portion is scrub forests (294 acres or 119 ha), while squatter farming makes up 749 acres or 303 ha (CIDA 1992). The Forest and Lands Department is currently vacating the remaining squatters. On Crown Lands, which constitute 3,909 acres (1,583 ha), a little over 1,000 acres (404 ha) of natural forest still exists, the rest being under intensive and mixed agriculture. Private land, accounts for 85% (129,403 acres or 52,390 ha) of the island's total land area. Of this, 27% is in natural vegetation, while 59% is under cultivation. On a point of interest, some 25% of the island or 38,652 acres (15,649 ha), is intensively farmed on slopes unsuited for this type of agriculture.

Rain forest has been reduced to 31,053 acres (12,572 ha). Between 1977 and 1989, 10,288 acres (4,165 ha) of rain forest and 12,750 acres (5,162 ha) of scrub forest were lost while agricultural land increased by 32,053 acres (12,971 ha) (table 1). This represents a 22.5% decline or a 1.9% per year decline

in forest area over this period. The high price of bananas during the 1980's motivated farmers to clearcut forested valleys and steep slopes to support banana production. This practice has dramatically changed the forest ecosystems, wildlife habitats, watersheds/catchments and intakes, and the environment in general. The loss of biodiversity is especially evident in areas of forest and natural habitat endangerment, as a direct consequence of increasing industrialization and poor agricultural practices. This also impacts heavily on the marine ecosystem.

Table 1. - Comparison of land use tabulation (1977 – 1989).

Category	Area (ac) 1977	1989	Difference
Forest	41,341	31,053	-10,288
Scrub forest	31,312	18,562	-12,750
Grass and open woodland	3,215	6,584	3,369
Sub-total	75,868	56,199	-19,669
Intensive agriculture	35,810	43,412	7,602
Mixed agriculture	15,575	40,026	24,451
Sub-total	51,385	83,438	32,053

Source 1977: O.A.S. 1987
Source 1989: C.I.D.A. 1992

The Forest Ecosystem

Natural Vegetation Types

In 1944, a forester from Trinidad, Mr. S. J. Beard, presented the first comprehensive report on the status and structure of the island's forest resource. He estimated that 50% (64,444 acres or 26,091 ha) of St. Lucia was covered by natural forest types and (fig. 1) described five main categories: rain forest, lower montane rain forest, montane thicket elfin woodland, secondary forest, and dry scrub woodland. The principal forest tree species recorded in Beard's ecological survey are gommier (*Dacryodes excelsa*), chataignier (*Sloanea caribaea*), mahaut (*Sterculia caribaea*), bois de masse (Licania ternatensis), laurier cannelle (*Phoebe elongata*), bois pain marron (*Talauma dodecapetala*), balata chien (*Neoxytheca pallida*), palmiste (*Euterpe globosa*), bois cote (*Tapura antillana*), l'encens (*Protium attenuatum*), goyavier (*Myrcia* spp.), corosol marron (*Guatteria caribaea*) and bois blanc (*Simarouba amara*). A total of 151 tree species were identified representing 62% of the tree flora. Of these, 35 tree species were found to be endemic to St. Lucia.

In 1981-83 an inventory specialist, P.O. Piitz, conducted a forestry inventory that identified nine climax forest communities on the island. The rain forest and lower montane rain forest account for nearly all the commercial timber land with nearly 11% of the total land area. During the inventory, 104 tree species were enumerated. Six of these account for nearly 55% of the merchantable volume: gommier, chataignier, balata chien (*Oxythece pallida*), bois de masse, bois pain marron and mahaut cochon. Table 2 compares stems-per-acre for major rain forest and lower montane rain forest as enumerated by Beard (1949) and Piitz (1983).

Analysis of Forest Surveys

The results shown in table 2 indicate that the number of stems per acre in the rain forest and lower montane rain forest types has declined from 30.6% to 56%. The primary tree species affected are gommier, chataignier, bois de masse, laurier canelle, and bois pain marron. However, mahaut cochon has increased by 63%. The analysis shows that the main canopy of the rain forest is threatened. It also shows that openings are occurring within the forest, allowing aggressive, light-demanding trees to establish rapidly. Many trees have been cut for timber and boat and canoe building and about 70% of the forest area was affected by natural disasters during the period in question (Hurricane David, 1979; Hurricane Allan, 1980).

Figure 1. - Vegetation map of St. Lucia.

Table 2. - Stems/acre of major rain forest/lower montane rain forest species as enumerated by Beard (1949) and Piitz (1983). Values of rain forest and lower montane rain forest are grouped and based on eight ha.

Common name	Scientific name	Beard	Piitz
Gommier	*Dacryodes excelsa*	9.8	6.8
Chataigner	*Sloanea caribaea*	4.7	2.8
Mahaut	*Sterculia caribaea*	7.4	12.1
Bois de masse	*Licania ternatensis*	7.2	4.0
Laurier canelle	*Phoebe elongata*	1.1	0.4
Bois pain marron	*Talauma dodecapetala*	0.9	0.6
Palmiste	*Euterpe globosa*	28.4	not listed
Bois cote	*Tapura antillana*	10.8	**
Balata chien	*Oxytheca pallida*	6.2	3.5
Goyavier	*Myrcia* spp.	6.5	**
Corosol marron	*Guatteria caribaea*	2.6	4.4
Bois blanc	*Simaruba amara*	0.9	1.1
Paletuvier	*Tovomita plumieri*	5.7	3.4
L'encens	*Protium attenuatum*	4.2	4.1
Casse	*Swartzia caribaea*	2.1	**
Grigri	*Aiphanes luciana*	0.6	**
Feuille doree	*Micropholis chrysophylloides*	2.1	1.7
Merise	*Ternstroemia oligostemon*	2.3	0.2
Bois riviere	*Chimarrhis cymosa*	<1.0	2.4
Laurier mabre	*Endlicheria sericea*	<1.0	2.3
La glu	*Sapium caribaeum*	<1.0	2.1

** Listed as "other" species

BIODIVERSITY IN THE FORESTRY SECTOR

Background

St. Lucia is a small Caribbean island with a growing population. The economy of the island is based on agriculture and tourism. Demand for land for banana production in the 1980's put great pressure on the forest land. The economy also relies on the forest land for soil conservation, water production, charcoal, recreation (ecotourism), and various local uses. The protection and conservation of the forest and other natural resources, such as wildlife, soil, and water are the responsibility of the Forest and Lands Department, within the Ministry of Agriculture, Fisheries, Forestry and the Environment.

Island "biological resources" have suffered from unsound and sometimes indiscriminate use, leading to severe degradation of habitat and the demise of endemic flora and fauna. St. Lucia is no different from most small island developing states and, as such, has had its natural forest vegetation stripped off from the coastal areas and lowland habitats to the lower montane rain forests and rain forests habitats. There are several factors that increasingly threaten the island's biological diversity, *e.g.* habitat alteration, pollution, over-harvesting, deforestation, destruction of coral reefs, charcoal production, and loss of wetland ecosystems.

The most endangered terrestrial species of St. Lucia occupy the coastal and inland habitats. A few are found in the rain forest. For example, the white breasted thrasher (*Ramphocinclus brachyurus*), is

found on the east coast of St. Lucia, and is endemic only to St. Lucia and Martinque. Another endangered species is the St. Lucia racer (*Leimodophis ornatus*), a snake restricted to Maria Island, its last refuge in the entire world. Two examples of endangered plant species are *Acalypha elizabethae*, a rare endemic species found on the piton, and *Beilschmieda pendula (*one specimen found in the rain forest at Des Cartier is being monitored for fruit production). The rain forest is home to a wide diversity of flora and fauna. Five endemic wildlife species are confined to St. Lucia's forests, including one of the rarest birds in the world, the St. Lucia parrot (*Amazona versicolor*).

Status of Biological Resources and Biological Diversity

Forest Reserves

The natural forests are present in the Government Forest Reserves (56%) and on private lands (43%). Scrub forests and mangroves are mainly found on private lands. The forest reserves comprise 14 units, located mainly on the central ridge of the island. In 1916, the Castries Forest Reserve was declared the first forest reserve in St. Lucia. The total acreage of the forest reserves is 18,526 acres (7,500 ha); 88.1% is made up of natural forest; 6.0% of plantation forest, mainly exotic species; 1.6% scrub forest; and the remaining 4.3% is occupied by squatters (845 acres or 342 ha) and the Roseau Dam reservoir (40 acres or 16 ha). Forest reserves were set aside for the protection of forests, soil, water and wildlife resources. These 14 units of forest reserves are managed by the Forest and Lands Department and are protected under the Forest, Soil and Water Conservation Ordinance (1946; amendments in 1983).

Wetlands Ecosystem

The wetlands of St. Lucia are small, but they represent most wetlands ecosystems (Deveaux 1988). The total area of St. Lucia wetlands has been reduced from 791 to 476 acres (320 to 193 ha), with some areas currently under considerable stress (table 3). The wetlands in Saint Lucia are made up of four types of systems: estuarine, riverine, palustrine, and lacustrine (Portecop and Benito Espinal 1985). The estuarine system is referred to as a fringing mangrove swamp and is considered to be the most productive wetland, while the riverine mangrove swamp is the most common wetland in Saint Lucia. The palustrine and the lacustrine system are important habitat for waterbirds.

Table 3. - Wetland types in Saint Lucia (Deveaux 1988).

Types of habitat	Example
Tidal flat	Praslin
Fringe mangrove	Marigot
Riverine mangrove	Dauphin
Basin mangrove	Bois D'orange
Salt water lagoon	Canelles
Reed marsh	Anse La Raye
Reed swamp	Marquis
Closed canopy swamp forest	Anse
GerHerbaceous swamp	Belle plaine
Forested wetland	Desraches
Fresh water marsh	Hewanorra W
Back swamp	Roseau
Inland delta	Roseau
Flood plain	Cul de Sac
Fresh water lake	Rabot
Dry stream thicket	Galette
Fresh water hole	Troumassee
Fish pond	Beausejour
Sewerage treatment pond	Hewanorra N

Problems of Wetlands in St. Lucia

Wetlands are among the most dynamic ecosystems on the earth. Wetland areas in Saint Lucia have been reduced by human activities such as deforestation, charcoal production, construction, land reclamation, garbage dumping, and pollution. Land clearing for agriculture, especially on the steep slopes, and for charcoal production has accelerated soil erosion. The silt transported to the coast affects the ecological balance of coastal wetlands, particularly the riverine system. Many developers view wetlands as wastelands where nothing can be done except to drain, fill, and reclaim them for development of some kind. In Saint Lucia, the lacustrine and palustrine systems have suffered the greatest loss (Deveaux 1988). These two wetland systems provided Saint Lucian hunters with good

hunting grounds for game birds until 1980. A reduction in the area of these two systems means that other non-game birds may become targets if and when hunting of wildlife is resumed in Saint Lucia.

Wetlands provide numerous benefits, both direct and indirect. In Saint Lucia the fishing industry, tourist industry, wildlife, and nature lovers all benefit immensely from the wetlands, so, there is need to manage this resource.

Protected Areas

In addition to the proclaimed Government Forest Reserves, there are 16 other protected areas:

The Parrot Sanctuary. - The Parrot Sanctuary covers a total area of 4,200 acres (1,700 ha), of which 95% lies within the forest reserves and 5% on private land. This area was set aside to protect the feeding and nesting areas of the St. Lucia parrot and other endangered forest wildlife.

Maria Islands Nature Reserve. - Two small islets off the southern coast are reserved for the protection of endangered wildlife, such as the ground lizard (*Cnemidophorus vanzoi*), and the St. Lucia racer or grass snake (*Liophis ornatus*). The total acreage of the reserve is approximately 30 acres (12 ha). These islands are managed by the St. Lucia National Trust, ably assisted by the Forestry and Fisheries Departments.

Pigeon Island National Park. - This is a historic park (20 acres or 8 ha) under National Trust management.

Savannes Bay Mangrove Area. - St. Lucia's largest mangrove is vested in the National Trust for preservation. Three coastal ecosystems (coral reefs, sea grass beds, and extensive mangroves) are represented at Savannes Bay. Total area protected is 1,200 acres (486 ha).

The other areas were declared as marine reserves in October 1986 and are mainly located along the sea shore:

- Savannes Bay mangrove (125 acres or 51 ha)
- Praslin mangroves (39 acres or 16 ha)
- Marquis mangroves (12 acres or 5 ha)
- Marigot Bay mangroves (7 acres or 3 ha)
- Grand Anse beach and mangroves
- Fond d'Or beach
- Esperance Harbour mangroves (12 acres or 5 ha)
- Anse Lavoutte (Cas-en-Bas) mangroves (27 acres or 11 ha)
- Bois d'Orange mangroves (7 acres or 3 ha)
- Anse Pointe Sable Mankote mangroves (120 acres or 49 ha)
- Fregate Island Nature Reserve: Avifaunal reserve
- Anse Mamin reef
- Anse L'Ivrogne reef

FLORA AND FAUNA

Flora

The biological diversity of the island of St. Lucia includes a total of 1,310 known species of flowering plants, 119 fern species, and 105 plants of known medicinal values. Of the total, 241 are forest tree species. In addition, the National Herbarium, located within the Forest and Lands Department, contains at least 2,000 plant specimens.

Endangered Plants

There are 27 endangered plant species in St. Lucia (table 4). Most of these are found in coastal and lowland habitats, where they are threatened by agriculture, charcoal production, and other forms of development. Although the rain forests which are within the Government Forest Reserves are protected by legislation, few endangered plants occur in this type of habitat.

Of the 27 species listed in table 4, two, *Tetrazygia angustifolia* and *Myrcia leptocelda,* are at immediate risk of extinction because their limited habitat is threatened by urban development. Also, two species associated with fresh water swamps, *Pavonia spinifex* and *Montrichardia arborescens* are at risk due to disappearance of habitat. Table 5 lists eight endemic plants found in St. Lucia. Previous reports show a higher number of endemics for St. Lucia, but a recent compilation by Roger Gravenson (1998) indicates that some of the plants recorded as being endemic are found in other countries in the region.

Table 4. - Most endangered plant species of St. Lucia.

Scientific names	Family	Common names
Dicotyledons		
Acalypha elizabethae	Euphorbiaceae	
Beilschmiedia pendula	Lauraceae	Lowye wouj
Bernadia laurentii	Euphorbiaceae	
Celtis iguanaea	Ulmaceae	
Dodonea angustifolia	Sapindaceae	
Exothea paniculata	Sapindaceae	Acomat
Forestiera rhamnifolia	Oleaceae	Bwa kaka wavet
Licania leucospala	Chrysobalanaceae	
Machaerium lunatum	Fabaceae	
Malanea macrophylla	Asclepiadaceae	
Morisonia americana	Capparidaceae	
Myrcia leptoclada	Myrtaceae	
Myrcianthes fragrans	Myrtaceae	
Pavonia paludiola	Malvaceae	
Pavonia spinifex	Malvaceae	
Picramnia pentandra	Simarubaceae	Bwa moudon
Picrasma excelsa	Simarubaceae	Sip amer
Pisonia aculeata	Nyctiganaceae	
Richeria grandis	Euphorbiaceae	Bwa bande
Salvia lamiifolia	Lamiaceae	
Schaefferia frutescens	Celatraceae	
Sideroxylon foetidissimum	Sapotaceae	
Tetrazygia angustifolia	Melastomataceae	
Ximenia americana		
Monocotyledons		
Acrocomia aculeata	Arecaceae	
Geonoma martinicensis	Arecaceae	Goblet
Montrichardia arborescens	Araceae	
Juniperus barbadensis	Cupressaceae	Pencil cedar

Fauna

An outstanding degree of biodiversity is concentrated in this small land mass, the island of St. Lucia. There are over 150 bird species, 14 reptiles, 9 mammals, and 4 amphibians found in St. Lucia.

Endemic Birds

- The St. Lucia parrot (*Amazon versicolor*) also known as Jacquot, is the national bird. It was known to have an estimated population of 150 birds after hurricane Allen in 1980 (Butler and Jeggo 1980). The population had increased to 200 – 250 birds by 1987 (Jeggo 1987) and nine years later, the population estimate was between 400 – 450 birds (1996 Parrot census, unpublished).
- The St. Lucia black finch (*Melanospiza richardsoni*) is widely distributed in all habitats, but uncommon everywhere (Trail and Baptiste) and regarded as threatened (Collar 1988).
- The Semper's warbler (*Leucopeza semperi*) inhabits the forest understorey. The status of *L.*

Table 5. - Endemic plants found in St. Lucia.

Scientific name	Family	Common names
Acalypha elizabethae	Euphorbiaceae	
Aiphanes luciana	Arecaceae	Gwi gwi
Bernardia laurentii	Euphorbiaceae	
Chrysochlamys caribaea	Clusiaceae	Mango mang
Daphnosis macrocarpa	Thymeleaceae	Maho piman gwan bwa
Miconia luciana	Melastomataceae	Bwa senn
Miconia secunda	Melastomataceae	
Siparuna sanctae-luciae	Monimiaceae	Bwa kaka

semperi is still unknown, it was last seen in the late 1970's and is listed by some as extinct and by others as endangered.

- The St. Lucia oriole (*Icterus laudabilis*) is generally distributed throughout most habitat types and in no immediate danger, provided habitats are not destroyed (Faaborg and Arendt 1985).
- St. Lucia pewee (*Contopus oberi*) is fairly common and in no present danger.

Endemic Sub-Species

- The St. Lucia white breasted thrasher (*Ramphocinclus brachyurus*) is now critically endangered as a result of habitat destruction by encroachment of farmers and charcoal burners.
- The St. Lucia rufos nightjar (*Caprimulgus rufus*) is a subspecies of the South American species, occurring only on St. Lucia in the Caribbean. The species is nocturnal, and is found in the dry scrub forest and woodlands. The species is considered to be endangered due to habitat destruction.

Other Threatened Endangered Species

The St. Lucia wren (*Troglodytes aedon mesoleucus*) and the St. Lucia forest thrush (*Cichlherminia therminier sanctaeluci*) are both rare and endangered. St. Lucia was once home for countless sea birds, ground-nesting birds, and other avian species, but now many can only survive by moving off the main island to offshore islands and caves where they will not be harassed and their nests will be safe.

Mammals and Reptiles

St. Lucia has only a few mammals and reptiles, including five endemic reptiles and six regionally endemic reptiles (table 6). Some examples of reptiles are the house gecko (*Hemidactylus mabouia*), rock gecko (*Hemidactylus palaichthus*), and the tree gecko (*Thecadactylus rapicauda*).

The only known endemic mammal was the St. Lucia muskrat (*Megalomys luciae*), which is now apparently extinct (ICBP 1988). Although persons from the Des Barra community have reported root crops being eaten by the muskrat, no one has seen it. Table 7 lists the of mammals recorded in St. Lucia and their status.

Amphibians

Only four amphibians are found in St. Lucia, most of them being frogs. The large "mountain chicken" or "crapaud" frog (*Leptodactylus fallax*), is reportedly extinct (Faaborg and Arendt 1985). Table 8 lists the amphibians found in St. Lucia and their status.

Invertebrates

One threatened invertebrate, a subspecies of the Hercules beetle (*Cynastes hercules reidi*), is found in St. Lucia. It is confined to the montane areas and is threatened primarily by habitat destruction and the indiscriminate use of pesticides.

Table 6. - Reptile species recorded in St. Lucia.

Scientific name	Family	Status
Anolis rouquet extremus	Tree lizard	RE
Anolis wattsi wattsi	Tree lizard	RE
Bothrops caribbaeus	Fer-de-lance snake	E
Constrictor constrictor orophias	St. Lucia boa constrictor	E
Cnemidophorus vanzoi	St. Lucia whiptail, zando	E
Gymnophthalmus pleei luetkeni	Microteiids lizard	R, RE
Iguana iguana iguana	St. Lucia iguana	R
Leptotyphlops bilineata	Worm snake	R, RE
Liophis ornatus	St. Lucia racer	E, VR
Sphaerodactylus microlepis thomasi	Pigmy gecko	R, RE
Sphaerodactylus vincentin diamesus	Pigmy gecko	R, RE
Sphaerodactylus microlepis microlepis	St. Lucia Pigmy gecko	E, C

Key - R: Rare E: Endemic RE: Regionally endemic C: Common VR: Very rare

Table 7. - Mammals recorded in St. Lucia.

Scientific name	Common name	Status
Ardops nichollsi	››	RE
Brachyphylla cavernum	Cave bat	RE
Dasyprocta antillensis	Agouti	Common
Didelphis marsupialis	Opposum	Abundant
Herpestes auropunctatus	Mongoose	Abundant
Megalomys luciae	St. Lucia muskrat	Extinct, E
Monophyllus plethodon	Fruit and nector-eating bat	RE
Musculus spp.	Mouse	Common
Rattus rattus	Rat	Abundant

Key - E: Endemic RE: Regionally endemic

Table 8. - Amphibians found in St. Lucia.

Scientific name	Family	Status
Bufo marinus Linnaeus	Toad	Common
Eleutherodactylus johnstonei Barbori	Piping frog	Abundant
Hyla rubra Daudin	Frog	Rare
Leptodactylus fallax	Mountain chicken	Extinct

MANAGING BIODIVERSITY

The responsibility for the conservation and sustainable management of St. Lucia's terrestrial flora and fauna rests with the Forest and Lands Department of the Ministry of Agriculture, Forestry, Fisheries and The Environment. Recognizing the rapid increase in deforestation and realizing the drastic effects of deforestation on the forest ecosystem (flora, fauna, soil, and water resources), the Department moved expeditiously to ensure sound management of the natural resource base of St. Lucia. This is in the Ten Year Management Plan (1992 – 2002) Volumes 1 and 2. The following policies and strategies illustrate the efforts being made toward the conservation of biodiversity.

Forest Protection and Management

Goal: "To protect and conserve the natural resources" for the protection of the environment, and to obtain maximum utilization consistent with sustainable development, and the welfare of the rural communities and the country as a whole.

Strategies: The plan has three specific objectives.
1. To protect and conserve the forest reserves and protected areas and expand them where deemed necessary for wildlife (fauna and flora), soil and water conservation. The St. Lucia parrot is still endangered and knowledge other fauna species as well as their habitats is deficient. The last ecological survey was done in 1944, so, the knowledge of vegetation classification needs to be updated. Maintaining the forest reserve and protected areas in it's forested state is of utmost importance for the protection of the watershed, water catchments, and biodiversity. To guide in the management of forest reserves three management classes and recommended treatments were developed.

Protection Forestry. – In forests existing on slopes greater than 31°, massive interventions are allowed, only conservation works and remedial operations to maintain biodiversity.

Production/Protection Forestry. – In forests cohesive soils with slopes varying from 21° to 30° policy allows the following sound forest management activities:

- enrichment planting using local and exotic species
- low intensive selective cutting
- non mechanized extraction techniques
- recreation activities

Production Forestry. – In forests existing on moderately cohesive soils with slopes not greater than 20° and on low cohesive soils with slopes not greater than 10°, policy allows the following sound forest management activities:
- enrichment planting
- selective harvesting
- forest hygiene maintenance
- recreation activities

Plantations Established for Commercial Purposes. - Felling in forest reserves is confined to limited, licensed sales of trees larger than 4 to 5 feet in girth, depending on species. This is described as a one-tree selection system. Timber extraction from the forest is by hand, followed by conversion by an Alaskan mill.

2. To protect and conserve the natural resources (wildlife, soil, and water) on private land within watersheds and catchments, the land-use conflictive areas, buffer zones around the forest reserves and the river banks (in general) all over the island. The Department developed the following activities for implementation on private land:
- conducting intensive extension forestry activities in the buffer zones around the reserves, in areas within water catchments and in forested areas
- establishing community forestry groups and the continuation of community woodlots management
- acquiring private forested land for expansion of the forest reserve
- intensifying extension forestry activities in areas of high land-use conflict and along river banks

3. To protect and conserve the natural resources (wildlife, soil, and water) of Crown Lands within the watersheds and catchments, the land-use conflictive areas, a buffer zone around the forest reserves, the river banks and in general all over the island. The following activities were developed and implemented on Crown Lands:

- establishing management guidelines that will maintain the integrity of the land
- giving technical assistance to land tenants, to help them implement the guidelines in the extension manual
- promoting water conservation activities in water catchments on Crown Lands
- planting trees on steep slopes and on river banks

One of the specific objectives is to expand the forest reserves and protected areas to help protect and conserve the natural resources of St. Lucia.

Legislation

When a species population falls, or rain forest habitats important for soil and water conservation are being destroyed, legislation serves as one of the tools to alleviate the problems. The conservation of biodiversity and natural resources in St. Lucia cannot be seen separable. As far back as 1885, wildlife species, principally birds, have been protected by legislation (The 1885 Wild Bird Protection Ordinance). Also, in 1946 the Forest, Soil, and Water Conservation Ordinance was passed and provides protection for the natural resources, including the flora, of St. Lucia.

In 1980, a Wildlife Protection Act was passed that updated and expanded upon the almost century-old Wild Bird Protection Ordinance. The new act increased the penalties for offences, and added mammals and reptiles to the species covered by the law. The 1946 Forest, Soil and Water Conservation Ordinance was amended in 1983, giving the Minister of Agriculture the power to declare private forest "protected forest" and also the power of acquisition of a protected forest.

Wildlife and Applied Research

Wildlife

The Wildlife Protection Act of 1980 lists six species of mammals and reptiles as absolutely protected, 79 species of birds as absolutely protected, 37 species of birds as partially protected, and the fer de lance viper, mangoose, mice, and rats as unprotected. Hunting was permitted until 1980 but was banned after Hurricane Allen in August 1980 and is still not allowed. Fines for convictions of offences under the act are set as high as EC$5,000.00 or 12 months in prison.

In support of domestic wildlife protection legislation, in December 1982 St. Lucia became party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), becoming the 83rd country to do so and one of the three Caribbean countries to sign the Convention.

Parrot Conservation Programme

In 1977 the Department of Forestry embarked on an intensive conservation programme to conserve the parrot population given the drastic decline in its numbers. The programme had several components:

1. The 1885 Wild Bird Protection Ordinance was reviewed and updated and the Wildlife Protection Act was developed in 1980.
2. The 1600-acre (648 ha) parrot sanctuary was established in 1980, and later expanded to 4,200 acres (1,700 ha); to protect the feeding and nesting areas of the St. Lucia parrot and other endangered forest wildlife.
3. A massive education programme began to make the St. Lucian population aware of the importance of forest protection and wildlife conservation. The Department sponsored film shows and slide presentations, publications in local newspapers, and produced regular radio and television programmes. Other visual aids (such as billboards, posters, t-shirts, bumper-stickers) were all used in drawing public attention to environmental issues.
4. The establishment of a wildlife interpretation facility and later the opening of the Union Mini-Zoo, popular among school children has created the desired impact. Also, the development of "A Booklet for Children on St. Lucian Wildlife" which was distributed to all schools in the country. The production of the Bush Talk and the Jacquot magazine have all contributed to the success of the environmental education programme.
5. Parrot research activities have been conducted. Artificial nesting boxes have been erected to increase breeding sites for the parrot, and preferred tree species have been planted on a limited basis (1980). Regular censusing has been conducted to determine population and develop population indices.
6. In 1993, a collaborative venture began between Jersey Wildlife Preservation Trust (JWPT) and

the Department of Forestry. The first study examined the breeding biology and foraging ecology of the parrot, while the second study in 1994 focused on the breeding biology and parental behavior of the parrot during nesting and studied the phenology of plants that may be important as food to the parrot; some of the activities included captive breeding, construction of platforms, and building blinds.

Other Wildlife Species

1. Work is underway on several projects: Census of rare, threatened, and endangered faunal species and their respective habitats. In 1994 work began on the censusing of the St. Lucia white breasted thrasher, the St. Lucia wren, and the St. Lucia rufous night jar.
2. Recommendations have been made for the acquisition of land to secure habitats for the above species.
3. Creation of data base on St. Lucia wildlife.
4. Collaboration with other agencies (national and international) on wildlife problems.
5. Collaboration in the preparation of education and interpretive material on wildlife.
6. Management of the mini-zoo at Union.

Applied Research

1. Establishment of permanent sample plots (PSP's) in both natural forests and plantations, and co-ordination of measurements of the PSP's.
2. Establishment of native species trial plots; adaptation and growth studies.
3. Establishment of research plots for threatened flora species latanye (*Coccothrinax barbardensis*) and mauby (*Colubrina elliptico*).
4. Development of a Dendrology Manuel of Forest Trees in St. Lucia; ongoing.
5. Management of the National Herbarium; continuous upgrade and collection of specimens for herbarium.
6. Re-establishment of the medicinal garden: herbs, fruit trees, and flowering plants.

ENVIRONMENTAL EDUCATION

Environmental education has played a major role in changing people's attitude from one of hate and apathy for flora and fauna to one of love and appreciation for biodiversity. This was achieved through the following activities:

1. School programme: teacher training workshops; inter-regional production of Jacquot magazine; local production of educational material; co-ordination and operation of school programmes.
2. Community programmes: promoting and conducting programmes in communities adjacent to forest resources, water catchments, rivers, and degraded areas.
3. Tourism and the general public: development of four new forest trails and the rehabilitation of existing forest trails (rain forest walks, hiking trails, waterfall trails, bird watching tours, and interpretive centre); zoo education programme for school children; promotion of services to hotels and the general public including brochures, mass media advertisements, lectures for hotel guests, and the public at large.
4. Other management activities: promotion and formation of Community Forestry Groups; promotion of co-management initiatives among the Forestry Department, NGO's, and community groups; net-working of the extension services of the Ministry of Agriculture to promote good land-use practices.

BENEFITS OF BIODIVERSITY

Managing biodiversity yields several benefits. Below are a few from the forestry sector in St. Lucia:

1. Generation of revenue for government, and income for the hotel and tourism sectors, taxi services, and rural communities through ecotourism projects.
2. Establishment of "Community Forestry Action Groups" and the co-management approach for resources management.
3. Availability of a sustainable supply of foods, medicinal plants, timber, orchids, handicraft material, and secondary forest products.
4. A more aware and sensitized population.
5. Increased knowledge of specific fauna; database developed on the St. Lucia parrot.
6. Protection of germplasm banks.

Managing for biodiversity maintains healthy ecosystems, which is indirectly responsible for the supply of valuable ecological goods and services.

CONCLUSION

In conclusion, we would like to say that biodiversity management and natural resource conservation are similar and, as such, the forestry sector has been managing biological resources as far back as 1916 when the first Forest Reserve (Castries Waterworks Reserve) was established. Although the biodiversity of the country has not been fully studied and understood, several baseline studies on a few species of plants and animals, have provided information on the biological resources, their problems and hazards.

A number of gaps still exist, which shows a lack of total awareness and knowledge of biodiversity and biological resources management. However, in the absence of a "Biodiversity Programme" the Department of Forest and Lands is working toward filling in these gaps. An example is the success of the St. Lucia parrot project. The parrot population of St. Lucia is arguably the largest in the region. This is the result of 20 years of commitment to research and conservation through a collaborative approach among the Forest and Lands Department (FALD), the St. Lucian public, the Wildlife Preservation Trust International (WPTI), and the Jersey Wildlife Preservation Trust (JWPT).

The parrot has served as "mascot" to spread the message of environmental conservation of forests and all wildlife, including birds, mammals, reptiles and amphibians. Clearly, the concerted effort at conservation of the biological resources of St. Lucia is on in which the FALD takes tremendous pride, a reflection of the Department's motto- "La Foway Sa La Vie" (The Forest is Life).

BIBLIOGRAPHY AND REFERENCES

Beard, S.J. 1949. The natural vegetation of the Windward and Leeward islands. Oxford forestry memoirs, no. 21, Clarendon Press, Oxford, UK.

Butler, P. and D.F. Jeggo. 1980. Assessment of the effects of Hurricane Allen on the status of *Amazona versicolor*. Forestry Division, Ministry of Agriculture, St. Lucia.

Butler, P.J. and A. James 1991. St. Lucia parrot (*Amazona versicolor*): consolidating a conservation Campaign, RARE Center for Tropical Conservation.

Canadian International Development Agency. 1992. Forest Management and Conservation Project. Forest management plan; 1992 - 2002. Vol. 1 & 2. ROCHE Lte, Groups - Counsel.

Caribbean Conservation Association/ Island Resources Foundation. 1991. St. Lucia environmental profile.

Collar, N.J. 1988. Birds to watch. ICBP technical publication. Cambridge, UK.

Deveaux, J.R. 1988. The wetlands of St. Lucia: described, listed and evaluated. Unpublished.

Evans, P. 1990. Birds of the Eastern Caribbean. Macmillan Education Ltd., London.

Faaborg, J.R. and W.J. Arendt. 1985. St. Lucia. *In* Wildlife assessments in the Caribbean, pp. 127-157. Institute of Tropical Forestry, Rio Piedras, PR.

Graveson, R. 1998. St. Lucia plant list by Graveson. Version 1. March, 1998. Forest and Lands Department.

International Council on Bird Preservation (ICBP). 1988. Island database, St. Lucia (draft). Cambridge, UK.

Jeggo, D.F. 1987. The St. Lucia parrot (*Amazona versicolor*) 1975 – 1986: turning the tide for a vanishing species. Dodo 23 (1986): 59 - 68.

Long, G.E. 1974. The Serpent's Tale: reptiles and amphibians of St. Lucia. University of West Indies. Extra Mural Department, St. Lucia. Iquanaloa Series.

Piitz, P.O. 1983. Forest inventory report. Vol 1. St. Lucia/C.I.D.A., Forest management assistance project.

Portecop, J. and E. Benito Espinal. 1985. The mangroves of St. Lucia. Preliminary report. ECNAMP, St. Lucia.

Trail, L.M. and L.F. Baptiste. 1989. The behavior, status, and relationships of the endemic St. Lucia black finch. Nat. Geogr. Res. 5: 82 – 97.

BIODIVERSITY IN SURINAME: ITS MANAGEMENT AND BENEFITS

Krishnepersad Mohadin and Carlo Julen

INTRODUCTION

The Republic of Suriname, on the northeast coast of South America bounded by the Atlantic Ocean, French Guiana, Brasil, and Guyana, is almost 85% covered with tropical forest. The country is approximately 165,000 km″ in size and is divided from north to south into four zones:

- Young coastal plain (0-4 m asl) consists of Holocene swamp clays supporting mangrove forests, lagoons, herbaceous swamps, and several types of swamp forests.
- Old coastal plain (4-11 m asl) consists of swamp clays and sandy ridges covered with various types of grass and herbaceous swamps, swamp forests, dryland forests, and large areas of peat swamps.
- Savanna belt (10-100 m asl) is a dissected plain, characterized by white sand savannas that consist of coarse sands and loams. The zone is covered with xerophytic and mesophytic dryland and swamp forests and dry to wet grass and shrub savannas.
- Mountainous region (up to 1,230 m asl) covers three quarters of the country and is rugged terrain on the ancient Guayana Shield. The natural vegetation consists mainly of primary tropical rain forest interrupted by small patches of marsh forest along rivers and creeks.

Suriname has a multi-ethnic population of about 400,000 inhabitants, about 90% of whom live in the capital city of Paramaribo and smaller settlements on the coastal plain. The population of the interior consists mainly of Bushnegro's (descendants of runaway slaves) and indigenous people (Amerindians) which mostly live in scattered villages along the larger rivers.

BIODIVERSITY IN SURINAME

The flora and fauna of Suriname are well studied. Several comprehensive nature-oriented scientific expeditions were conducted in the past. These were scientific expeditions, zoological and botanical specimens were collected incidentally. As a result, a large body of information has been accumulated for some plant and animal species. Data for most plants and animals are still lacking, however.

Between 1976 and 1978, the ecosystems of northern Suriname were intensively inventoried and mapped resulting in the publication of the *Reconnaissance Map Suriname Lowland Ecosystem* (*Coastal Plain and Savannabelt*) as well as a proposal for the creation of six additional nature reserves. Large parts of the interior, particularly the hilly and mountainous area, still remain unknown. A proposal to inventory the ecosystems of the interior was developed in 1996 and awaits funding for implementation. The purpose of this project is to conserve, manage, and develop a representative part of the biological diversity of Suriname, in particular the area south of the savanna belt. In addition, a project, Flora of the Guianas, is now being carried out by the Herbarium of the University of Suriname in collaboration with the Herbariums of Utrecht, Berlin, London, Guyana, Paris, Cayenne, New York, and Washington. Biodiversity is also being inventoried under the Bioprospecting Project and is being carried out in Suriname by the Bioprospecting Group of Conservation International, the Bedrijf Geneesmiddelen Voorziening Suriname (Suriname Drug Company), the Missouri Botanical Garden, Virginia Technical State University, and Bristol Meyers-Squibb, and is aimed at the development of medicines. Furthermore, several small biodiversity projects are being carried out within the framework of the Special Commission on the Environment of

the Amazon Treaty, and a large biodiversity project will be developed soon for submittal to the United Nations Development Programme – Global Environmental Facility (UNDP-GEF). The National Zoological Collection of the University is studying indicators of biodiversity. And finally, the Natural Resources and Environmental Assessment Department of CELOS (Center for Agricultural Research in Suriname) is conducting a project, Ecological and Economic Inventory and Monitoring of the Amazon Tropical Rainforest Ecosystem of Suriname, aimed at mapping ecosystems of the interior.

Recent publications give the following estimates of the biodiversity of Suriname (table 1). The country harbors some 5,785 species of mosses, ferns, and Spermatophyta, 50 percent of which are endemic to the Guiana's. More than 380 species of Bryophyta (197 species of *Musci*, and 183 species of livermosses, Hepaticae) are found in Suriname. Eighty percent of the mosses are widely distributed in tropical America, but only about 2.5 percent are endemic to Suriname. There are 332 species of Pteridophyta (ferns).

The Spermatophyta Division is represented by 5,075 species, of which the Cycadospermae and Coniferospermae have no representative; the Chlamydospermae, 2; and the Angiospermae (the flowering plants), 5,073, the best known group in Suriname. The largest families of the Spermatophyta are Orchidaceae with 350 species, the Poaceae with 200 spp., the Fabaceae with 190 spp., the Rubiaceae with 180 spp., the Cypereceae with 140 spp., the Euphorbiaceae with 130 spp., the Caesalpiniaceae with 115 spp., and the Mimosaceae with 100 spp. In addition, 900 plant species have been introduced, most of them useful in some ways.

Some 674 species of birds are known, of which five families have the most species: Tyrannidae has 65 spp., Formicariidae 45 spp., Thrauphidae 31 spp., Acipitridae 28 spp., and Trochilidae 27 spp. About 60 bird species are migrants, predominantly from North America. So far, no endemic species are known. However, the possibility of more species, should not be discounted since an inventory for most of the interior has yet to be conducted.

Suriname has 156 species of reptiles, of which the Serpentes with 87 species of snakes is the largest order in the country. Of the snakes, the non-poisonous family of Colubridae with 60 spp. is the most numerous. After the snakes, the lizards with 43 spp. are the most numerous reptile. Amphibians are represented by 103 spp., of which the Hylidae with 34 spp. are the most numerous.

The country has 790 species of fish, and 185 species of mammals, of which the bats with 638 spp. and the rodents with 15 spp. are the most numerous. Only a few invertebrates have been registered for the country: 136 species from the Bivalvia, 136 spp. from the Gastropoda, 260 spp. from the Odonata and about 67 spp. from the Meliponinae.

CONSERVATION AND MANAGEMENT OF BIODIVERSITY IN SURINAME

Nature conservation in Suriname began early in 1915 with the provision in Article 44 of the Police Penal Code, which required a permit to hunt or to capture wildlife on certain public lands. Based on this article, the first sanctuary was established in 1953 in the estuary of the Coppename River to protect breeding colonies of scarlet ibis. Later, in 1966, this sanctuary became the Coppename-monding Nature Reserve.

A milestone in nature conservation in Suriname was reached in 1948 when the Nature Protection Commission, an advisory Commission on nature-related issues was formed. In 1954, two important protective laws were enacted - the Nature Protection Law and the Game Law. The Nature Protection Law provides for the establishment of nature reserves by decree if of scientific, aesthetic or cultural value. Based on this law, Suriname has already created 13 nature reserves ranging in size from 100 to 220,000 ha to protect representative habitats: forests, savannas, coastal flats, and important breeding beaches for olive ridley, green, and leatherback turtles, and breeding sites for scarlet ibis and herons (fig. 1). The Nature reserves are managed by the Suriname Forest Service within the Ministry of

Table 1. - Known and estimated numbers of species occurring in Suriname.

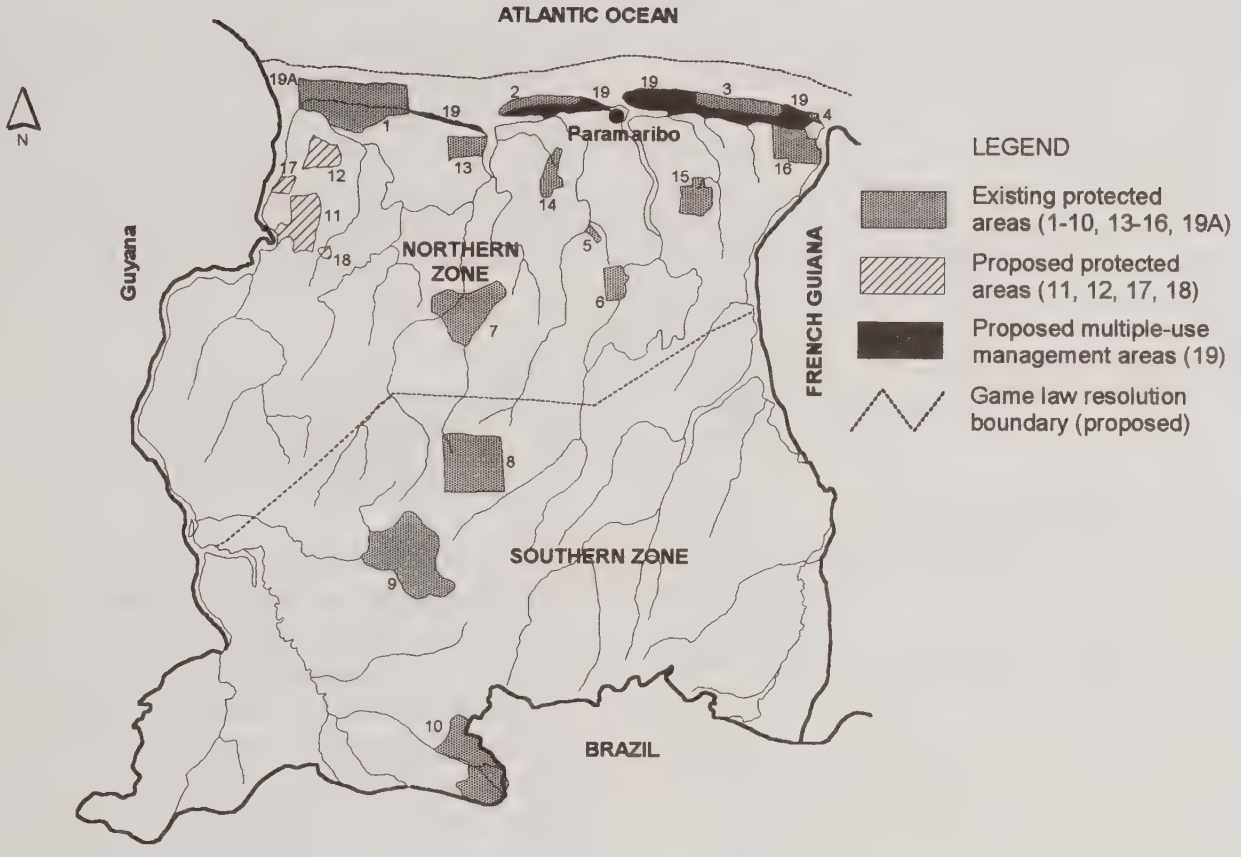
Taxa	Known number of species	Estimated number of species	Number of endemics	Quality of inventory
MONERA	?		?	--
PROTISTA	?		?	--
FUNGI		>60,000		
Mycophyta	?		?	--
Lichens	350	800	?	-
PLANTAE				
Bryophyta	380	650	9	+
Pteridophyta	330	450	?	+
Spermatophyta				
Angiospermae	5,075	6,000	?	++
Chlamydospermae	2	2		+
ANIMALIA				
Porifera	4		?	--
Coelenterata	12		?	--
Platyhelrninthes	7		?	--
Nematoda	72		?	-
Mollusca	299		?	+
Annelida	26	600,000-	?	-
Arthropoda		1,000,000		
Insecta	843		?	--
Others	305		?	-
Echinodermata	21		?	--
Chordata				
Pisces	790	850	>56	+
Amphibia	95	120	6	++
Reptilia	152	160	1	+++
Aves	668	680	0	+++
Mammalia	185	190	2	+++
TOTAL	9,611	>670,000	?	

The quality of the data presented is indicated by:

-- less than 10% known
- many taxa still hardly known, less than 50 % known
+ between 50-75 % known
++ between 75-90 % known
+++ probably more than 90% known

Natural Resources. Daily work is done by the Nature Conservation Division.

The Game Law, which applies outside the nature reserves, protects all wild mammals, birds, and sea turtles except those designated as game species, cage birds, or predominantly harmful species, and allows the status of any species to be changed by decree. The Game Law also protects the two caiman species: *Palaeosuchus trigonatus* and *P. palpebrosus*. Enforcement of this Law is also the responsibility of the Suriname Forest Service's Nature Conservation Division.



Existing protected areas in Suriname (1990)*

1. Hertenrits NR (100 ha)
2. Coppename Monding NR (12,000 ha)
3. Wia Wia NR (36,000 ha)
4. Galibi NR (4,000 ha)
5. Brinckheuvel NR (6,000 ha)
6. Brownsberg NP (8,400 ha)
7. Raleighvallen/Voltzberg NR (78,170 ha)
8. Tafelgberg NR (140,000 ha)
9. Eilerts de Haan Gebergte NR (220,000 ha)
10. Sipaliwini NR (100,000 ha)
13. Peruvia NR (31,000 ha)
14. Boven Cusewijne NR (27,000 ha)
15. Copi NR (28,000 ha)
16. Wane Kreek NR (45,000 ha)

19a. Bigi Pan MA (68,000 ha, excludes adjacent sea area)

Proposed protected areas in Suriname (1990)

11. Kaburi Kreek NR (68,000 ha)
12. Nani NR (54,000 ha)
17. Mac Clemen FR (6,000 ha)
18. Snake Kreek FR (4,000 ha)
19. Estuarine Zone MA (310,000 ha, of which 120,000 ha are already protected (see 1, 2, 3, 4, and 19a)

FR = Forest reserve

MA = Multiple-use management area

NP = Nature park

NR = Nature reserve

* = Hectares listed are estimates of land surface only

Figure 1. - Existing and proposed protected areas in Suriname. From Mittermeier & al. 1990. Conservation Action Plan for Suriname. (Map adapted by IITF, 1997)

Other legislation also protects wildland:

- The Law on Forest Management of 1992 provides for the establishment of "schermbos", "special protected forest", and "voorlopig in stand te houden bos."
- "Agrarische Wet" provides for obtaining wildland on long-term lease. Based on this law, the Foundation for Nature Preservation in Suriname (STINASU), a semi-governmental organisation, leased a part of the Brownsberg Plateau, which is now managed as a Nature Park.
- "Decreet L-2, Uitgifte Domeingrond" provides for creation of multiple-use management areas by putting some wildland areas at the disposal of a Ministry. For example, the Bigi Pan Area is being managed as a multiple-use management area by the Ministry of Natural Resources.

Other laws specifically affect the conservation of the biodiversity in Suriname:

- The Fish Protection Law sets size limits for freshwater species and determines fishing seasons for certain species.
- The Sea Fish Law prohibits certain fishing methods and affords the possibility to protect fishing areas at sea.
- The Pesticides Law deals with import, sale, handling, and use of pesticides.

USES OF AND THREATS TO BIODIVERSITY IN SURINAME

The varied uses of biodiversity in Suriname include the following:

- Many plants and animals are being used for food, medicine, and ritual purposes, especially by the Bushnegroes and the indigenous people.
- A project on bioprospecting of flowering plants has begun, but rules are not yet in place to regulate the contracts and the sharing of results and benefits gained from the research, development, and utilization of genetic resources.
- Forests are utilized for timber, recreation, and eco-tourism.
- Wild plants and animals are exported on yearly export quota system.

Human activities are the main threat to biodiversity in Suriname. Examples include the following:

- destruction of ecosystems by conversion to agriculture, urban development, mining, creation of lakes, etc.
- forest exploitation
- overfishing, uncontrolled hunting, and illegal trade in wild animals and plants
- pollution, particularly by agricultural chemicals and mercury in goldmining
- hydrological changes by the construction of dams and roads in estuaries, construction of lakes, and channalization of rivers.

ACTIVITIES RELATED TO CONSERVATION OF BIODIVERSITY IN SURINAME

Management of Protected Areas

Guard posts are planned for each protected area, equipped with sufficient qualified staff and equipment. It is also planned to develop a management plan for each protected area. Four protected areas now have management plans that include a detailed description of the area, objectives, strategies, and requirements for funds, infrastructure, and staff. One management plan has been developed for an area yet to be established as a multiple-use management area and two management plans are now being written.

Research, Training, and Education

Research is currently concentrated on collecting data on ecosystems and wild flora and fauna species. One of two courses for training game wardens and park managers has recently been completed. It is hoped to complete the second course soon. An Education and Public Awareness Campaign Program within the Nature Conservation Division and STINASU consists of film/slide shows; lectures, production of brochures, leaflets, posters and slide series; a mobile education unit; organizing displays; and writing articles for newspapers.

Accession to International Conventions on Conservation

Suriname is Party to The Convention of Biodiversity, The Amazon Co-operation Treaty, The Convention on International Trade in Endangered Species of Wild Fauna and Flora, The Ramsar Convention, The Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere, and the Convention on Climate Change. In addition, Suriname became Party to the Convention on Biodiversity in 1996, and is now developing a biodiversity strategy based on the principles of the Convention.

ORGANIZATIONS INVOLVED IN CONSERVATION OF BIODIVERSITY IN SURINAME

There are three principal entities responsible for biodiversity conservation the country: the Suriname Forest Service c.q. the Nature Conservation Division, within the Ministry of Natural Resources responsible for nature conservation, management, and enforcement of protective legislation; the Environment Department of the Planning Office within the Ministry of Planning and Development Co-operation responsible for developing national environmental policy; and the University of Suriname, involved in research and offering of courses. To a lesser extent three other ministries have responsibilities relating to environmental protection: the Ministry of Agriculture, the Ministry of Public Works and the Ministry of Public Health.

Some NGO's are involved in environmental protection and conservation:

- STINASU is involved in research, education and tourism within nature reserves.
- The Foundation for a Clean Suriname is mainly involved in strengthening public and governmental environmental awareness and improving exchange of information on environmental issues.
- Conservation International Suriname is involved in conservation of ecosystems and biodiversity but also emphasizes human development.
- The National Environmental Council, recently established by the President of Suriname, and the National Institute for Environment and Development, will be involved in developing, coordinating, and monitoring environmental legislation.

BIBLIOGRAPHY

Baal, F.L.J. 1991. Legal aspects of protected areas in Suriname. Report prepared for the IV World Congress on National Parks and other Protected Areas. Caracas, Venezuela, February, 1992.

Biodiversity Working Group (Adhin, sh. *et al.*). 1998. Nationale strategie voor het duurzame gebruik en het behoud van de biologische diversiteit.

Mittermeier, R. A. and *et al.* 1990. Conservation action plan for Suriname.

Mohadin, K. 1993. Conservation of freshwater ecosystems in Suriname. Pages 275-284 *in* P. E. Ouboter, ed. Freshwater ecosystems in Suriname.

Teunissen, P.A. 1977. Aanbevelingen tot uitbreiding van het systeem van natuurreservaten en bosreserves in het Surinaamse Laagland. (2de druk).

Werkhoven, M.C.M. 1996. Het prospekteren van de biodiversiteit. Paper presented for the "Tweede workshop nationale strategie voor het duurzame gebruik en behoud van de biologische diversiteit", January 30-31, 1996. Paramaribo, Suriname.

Werkhoven, M.C.M. and M.M. Held. 1989. Conservation of natural ecosystems versus land-use in Suriname.

BIODIVERSITY IN TRINIDAD AND TOBAGO ITS MANAGEMENT AND BENEFITS

Raye A. Sandy and Sheriff Faizool

INTRODUCTION

Trinidad and Tobago is located at the southern end of the Caribbean island chain and both islands have a tropical, wet climate. Trinidad has five main physiographic regions, which reflect the geological structure of the island: the Northern Range, Northern Basin, Central Range, Southern Basin, and Southern Range. Tobago has two main physiographic units, the Main Ridge and the Southwestern Lowlands.

Unlike the Caribbean islands to the north, which are mostly volcanic and arise from deep water, Trinidad and Tobago is situated on the South American continental shelf in close proximity to the mainland. The Northern Range is an extension of the Coast Range of Venezuela and is part of the eastern branch of the Andean Mountain System. Trinidad and Tobago are directly influenced by seasonal discharge from South American rivers, particularly the Orinoco River, but the influence is a graded one and more pronounced in Trinidad, especially in the southwest and the Gulf of Paria. During July to December, discharge of freshwater from the Orinoco delta decreases the salinity of coastal waters and increases the amount of sediments. As a consequence, there is a distinct gradation of communities and ecosystems from freshwater to oceanic extending from Icacos in southwest Trinidad to St. Giles in northeast Tobago.

Information on the biota of Trinidad and Tobago is extensive and dates back over 150 years. The flora is well documented and has been serially published by the government since the early 1920s. Attention is yet to be paid to lower plants, marine fungi, and some groups of marine algae. Some faunal groups, for example the vertebrates, are well documented but larger groups such as insects are only partially documented, and arachnids poorly documented. Documentation of marine groups is more recent and consequently less comprehensive, but marine algae and some key invertebrate groups are fairly well known.

While there is some knowledge of many individual taxonomic groups and some communities, detailed studies on specific ecosystems are few. In the terrestrial environment, there have been comprehensive evaluations of some forests, the savannas, palm forests, major wetlands, and a few stream systems. In the marine environment, there have been fewer studies and these include some coral reefs in Tobago and Trinidad and sheltered mud-bottom areas in the Gulf of Paria.

SPECIES NUMBER AND DIVERSITY

Trinidad and Tobago's biota is rich in numbers of species, typically South American, and mainly a relict of what was present when the islands separated from the mainland. In addition, there are many exotic plant species as well as a few exotic animal species that are now well established parts of the biota. Some species considered indigenous may in fact be exotics, introduced by the first settlers, the Amerindians. A number of species, both plant and animal may be locally rare. Overall estimates of numbers of species fall somewhere between 10,000 and 15,000.

Differences in size between Trinidad and Tobago as well as differences in topography, soil, and climate account for the greater richness of biota and ecosystems in Trinidad. Although at one time several species were listed as being island endemic, recent research has revealed that many of these are in fact also found on the adjacent mainland. Current knowledge of evolutionary processes also suggests that the time elapsed since separation is insufficient to permit formation of new species. There is some evidence of the presence of geographical races.

FLORA

The flora of Trinidad and Tobago consists of approximately 2,500 species in about 175 families. The families with the largest numbers of species are the ferns and related groups, with approximately 310 species; the grasses, legumes, and orchids, each with about 200 species; and the sedges, madders, melastomes, composites, and euphorbs, each with about 90 species (table 1). There is strong circumstantial evidence of continuing natural colonization and consequent enrichment of the indigenous biota of the southwestern peninsula of Trinidad from the Orinoco delta. In addition to the native flora about 300 exotic species exist in Trinidad and Tobago. Various tree-crop and timber species may be found in highly disturbed areas. Many exotic grasses and various ornamental species are found, some throughout the country even in remote areas.

Table 1. - Summary listing of the large plant families.

Family	Genera	Species
Ferns & allies	66 (51)*	310 (214)*
Grasses	74	214
Legumes	75	202
Orchids	68	109
Sedges	22	111
Rubiaceae	48	97
Melastomes	22	95
Composites	45	8
Euphorbs	27	82

* Ferns only

Terrestrial Plant Communities

Although the settlement and social development of Trinidad and Tobago have severely altered native plant communities and their associated biota, the process has not been devastating. It is still possible to see the full range of plant communities existing from pre-Columbian times, although they may be under constant pressure. Indeed natural vegetation has been significantly reduced and disturbed during the past 5 decades. Several distinct communities are recognized. At low elevations, there are (1) evergreen seasonal forests typical of high rainfall areas, (2) semi-evergreen, seasonal forests found in average rainfall, (3) deciduous, seasonal forests in low rainfall areas, and (4) dry evergreen forests, which are coastal adaptations to high winds and salt spray. At higher elevations and where there is impeded drainage, a range of forest and plant communities may be found including swamp forest, palm forest, marsh forest, savannah, herbaceous swamp, and mangroves typical of saline conditions.

Marine Plant Communities

In the marine environment, the principal plant communities found are the phytoplankton, seagrass beds, and marine algae. Phytoplankton communities are confined to the water column that is in constantly flowing through the area, and so are generally independent of the land masses. Sea grasses are usually found in shallow, sheltered water on firm sandy bottoms. Sessile algal communities are found mainly on hard substratum, often in exposed, high-energy conditions, and many species are adapted to deeper water than are sea grasses. Sessile algal communities often include sponges and corals.

Utilization of Flora

Only about 50 native plant species are harvested for use (table 2). Three exotic species, teak, mahogany, and Caribbean pine, have become important to the local timber industry, with teak and pine forming extensive monocultures. Pine has generally been planted to quickly restore cover to areas burned by wildfires. Teak, introduced from Burma in 1913, has generated revenue mainly from the sale of thinnings and mature logs. The former practice of removing natural forests to create teak plantations has been discontinued.

Plants are used for various other purposes. Tree ferns, for example, are harvested for use as orchid-growing medium, while different palm stems and other tree species are used in basket making. Some species, particularly aroids and ground pines, are harvested for foliage while others are used in gardens as ornamentals. One species, ryania, is harvested and exported for the production of an insecticide,

Table 2. - Major timber species utilized.

Local Name	Species	Family
Class I		
Acoma	*Sideroxylon quadriloculare*	Sapotaceae
Balata	*Manilkara bidentata*	Sapotaceae
Balsam	*Copaifera officinalis*	Legummosac
Cedar	*Cedrela odorata*	Meliaceae
Cypre	*Cordia alhodora*	Boragmaceae
Locust	*Hymenaea courbaril*	Leguminosae
Mahogany	*Swietenia macrophylla*	Meliaccae
Poui	*Tabebuia spp.*	Bignoniaceae
Roble	*Platymiscium trinitatis*	Leguminosae
Samaan	*Samanea saman*	Leguminosae
Teak	*Tectona grandis*	Verbenaceae
Class II		
Angelin	*Andira inermis*	Leguminosae
Crappo	*Carapa guianensis*	Meliaceae
Fiddlewood	*Vitex* spp.	Verbenaceae
Fustic	*Chlorophora tinctoria*	Moraceae
Galba	*Calophyllum lucidum*	Guttiferae
Guatacare	*Eschweilera subglandulosa*	Lecythidaceae
Laurier black	*Nectandra mortiniansis*	Lauraceae
Laurier Canelle	*Aniba panurensis*	Lauraceae
Laurier cypre	*Ocotea oblonga*	Lauraaceae
Mora	*Mora excelsa*	Leguminosae
Olivier White	*Terminalia amazonia*	Combretaceae
Pine	*Pinus caribaea*	Pinaceae
Podocap	*Podocarpus coriaceus*	Coniferae
Purpleheart	*Peltogyne porphyrocardia*	Leguminosae
Serrette	*Bursonima coriacea*	Malpighiaceae
Tapana	*Hieronyma caribaea*	Euphorbiaceae
Toporite	*Hernandia sorora*	Hernandiaceae
Yoke	*Astronium obliquum*	Anacardiaceae

Ryanex. A few species are of global importance in horticulture, the double chaconia (*Warszewiczia coccinea*), a mutant form originating in Trinidad, being significant. Some bee orchids and bromeliads are exported and many native species are used, both leaves and bark, for folk remedies. Mangrove wood is no longer used as fuel but its bark is still used in tanning. Except for a few fruit and a marine alga - sea moss (*Gracilaria spp.*) few native species are used as food. During the past 2 decades utilization of natural forest communities has expanded to include ecotourism and scientific study in the Northern Range of Trinidad, and a trend has begun in the past few years to use other areas such as the Main Ridge in Tobago.

FAUNA

Published knowledge of the fauna of Trinidad and Tobago is extensive. One group of terrestrial animals, the vertebrates, which is smaller in number than either insects or arachnids, numbers almost 600 species. If marine fish, reptiles and mammals are added, the total number exceeds 1,000 species. Unlike the case of the flora, publications on fauna are scarce, of uneven quality, and unsupported by direct government action. Moreover, immense gaps in knowledge exist, with some groups being virtually ignored.

About 45 freshwater fish, 30 amphibians, 85 reptiles, slightly more than 400 birds, and 95 mammals, have been recorded in Trinidad. The numbers for Tobago are significantly smaller owing to smaller size of that island, although some Antillean species found there are not found in Trinidad. Many of the birds are regular migrants, but as many as 250 species breed in Trinidad and Tobago.

Of the terrestrial invertebrates, the insects are best known. The well-documented groups include butterflies, dragonflies, caddis flies, water bugs, termites, ants and wasps, mosquitoes, sandflies, some beetles, and bugs. It is impossible to estimate numbers, but the butterflies and moths alone probably exceed 1,500 species. In contrast, arachnids and round-worms, which are numerous in many terrestrial systems, are poorly documented. The rest of the terrestrial fauna is also poorly known but includes some flat-worms, roundworms, earthworms, molluscs, crustaceans, and millipedes. On the basis of what is known about other neotropics area, a total terrestrial fauna probably exceeds 10,000 species.

The coastal waters of Trinidad and Tobago support a range of fish species, both pelagic and demersal finfish as well as shellfish. In addition, sea turtles are found nesting on several beaches in Trinidad and Tobago. The marine fauna is not well documented. There has been no recent study of the marine fishes of Trinidad although much can be extrapolated from reports on the fishes of the Caribbean region. The invertebrate groups documented include sponges, corals, marine worms, some gastropods, crabs, other crustaceans, and obscure minor groups. Again, as in the case of the fishes, much information can be deduced from the literature of the wider Caribbean region to assist in local management and determine research priorities.

Faunal Distribution

Although much of the terrestrial fauna, especially the invertebrate microfauna, is widely distributed throughout the country, the vertebrate macrofauna prefers certain well-defined habitats. Birds, for example, display distinctive assemblages associated with elevated forests, savannas, cleared areas, human habitations, public dumps, tree crops, wetlands, coastal areas, and the open sea. Similarly, freshwater and estuarine fishes, amphibians, and reptiles prefer distinct habitats. The mammals are mostly bats and rodents, the distribution of the former being determined by roosting and feeding habits and the latter by dietary and habitat requirements. The game mammals are mostly creatures of the forests, but the agouti may be seen in cleared and built-up areas. Although there are several caves in the country, especially in the northern and central parts of Trinidad, most of the cave dwellers are species associated with the adjacent forest and the only obligate cave species is the blind cave fish of the Oropouche Cave.

Distinctive marine communities are found in substratum types. Most of the sea bottom under the jurisdiction of the country consists of mud. Near shore there may be sandy bottom, beaches, rocky shores, and coral and algal beds. Although there is some variability, community type may reflect other factors, such as illumination, energy, and water quality. Coral reefs generally display the greatest diversity. Many fish species may be found over more than one type of sea bottom. Distinctive communities are also found in the water column.

Exploitation of Fauna

Only a few faunal species are used for food. Many marine species and some freshwater fish, molluscs, and crustaceans are also used as food. Some mammals, including deer, lappe, tattoo and agouti, manicou, and wild hog, and the common iguana are hunted but do not constitute a major food source.

Many vertebrate species are utilized other than as food (table 3) the thriving pet trade in birds, particularly finches. Indeed some species of finch have become extremely rare because of over-collection. Also, several bat species from Trinidad are now routinely used as laboratory animals in the United States. Caimans are harvested for the manufacture of curios or kept as pets.

BENTHIC COMMUNITIES

The shallow-water sublittoral of Trinidad and Tobago displays the full range of benthic communities to be found in the Caribbean biogeographical province. The distribution of these communities is determined partly by local bathymetry and substratum type, but mostly by the salinity and turbidity from the Orinoco River. Some coral reef communities in Tobago are less severely effected of the Orinoco River. Along the eastern part of the Northern Range and offshore east of the east coast, hard-bottom coral and algal communities may be found. In deeper water, as may be expected, the sea bottom is mainly mud.

KEY SPECIES AND ECOSYSTEMS

Although few species are endemic to Trinidad and Tobago, several key species are of note. Key species often give advanced warning of problems that may adversely affect human society. Dying monkeys indicate an outbreak of yellow fever that may quickly move to urban areas. The absence of gill-breathing freshwater fishes in a stream warns of anoxia resulting from organic pollution. Many species of higher vertebrates have charismatic appeal and their conservation can be highly effective tools in giving focus to environmental education and awareness from early ages. Common species, such as humming birds and the scarlet ibis, have special

Table 3. - Some exploited animal species.

Use	Local name	Species
Laboratory animals, reproductive biology	Bats	*Carollia perspicillata* *Molossus ater* Molossus major
Research	Fish bat Vampire	*Noctiho leporinus* *Desmodus rotundus*
Pet trade	Song birds (finches)	*Sporophila intermedia* *Sporophila nigricolli* *Sporophila minuta* *Oryzoborus crassirostris* *Oryzoborus angolensis*
Pet trade	Parrot	*Pionus menstrus* *Amazona amazonica*
Curios	Alligator	*Caiman crocodilus*
Pet trade	Iguana, guana	*Iguana iguana*

appeal simply for their unusual beauty and display. Manatees, ocelots, marine turtles, some butterflies (such as the emperor), showy orchids (such as the Cedros bee and the butterfly orchid), and tree ferns also have this appeal.

Trinidad and Tobago enjoys a wide range of ecosystems that are determined by location and physical characteristics. Some of these systems are key in the same sense as key species in that they have a special appeal. Coral reefs, wetlands, cloud forest, savannahs, and river gorges are examples (table 4).

EFFECTS OF DEVELOPMENT ON BIOLOGICAL DIVERSITY

Human population growth has affected and continues to profoundly affect the natural environment. In addition to the simple need for space for settlement, industrialization, and agriculture, which reduce the area of natural environment, the principal causes of damage include squatting, shifting cultivation, recurrent fires, illegal hunting and unrealistic game laws, irregular forestry practices and illegal logging, unplanned building and

Table 4. - Key ecosystems.

Ecosystem	Special characteristics	Location
Cloud forest	High rainfall/humidity/cloud - stunted trees - many mosses and lichen	Summit of El Tucuche and Cerro del Airpo
Xerophytic forest	Low rainfall/ extended dry season/ deciduous trees and cacti	Chacachacare
Herbaceous swamp	Semipermanent inundation - specialized flora	Nariva Swamp
Savannah	Poor drainage/nutrient poor - specialized flora	Aripo- The Aripo savannah is the only remaining undisturbed savannah in Trinidad
Mangrove swamp	Tidally inundated - specialized and much reduced flora	Caroni, South Oropouche, Los Blanquizales, North Oropouche
River gorge	Water worn channels in bedrock	Guanapo gorge, Madamas gorge
Fringing coral reefs	Emergent reef crest with lagoon	Buccoo, Salybia
Offshore islands	Isolated with breeding sea birds	St. Giles, Little Tobago, Soldado
Rocky shore	Resistant bedrock exposed by strong wave and current action- algal covered with many herbivores	North eastern Trinidad, Bocas area, Tobago.
Caves	Cavities in rocky strata - total darkness - bats and invertebrates	Aripo, Oropouche, Tamana

quarrying, illegal dumping and disposal of wastes, and irresponsible dumping of toxic materials.

One frequently unappreciated effect of human settlement is the collateral development of agricultural and forest ecosystems, some of which are diverse enough to rival natural systems and some of which support unusual assemblages of organisms.

Some of the above factors have severely disturbed the marine environment, especially near shore, in reclamation of coastal sites and establishment of industry. One effect of human population growth is the increased pressure on and depletion of marine fish stocks, particularly demersal species such as croaker, salmon, and sharks.

Management of Biological Resources

The biological resources of Trinidad and Tobago are managed through a patchwork of legislation, much of it archaic, and a system that spreads responsibilities over different agencies. Some protection is given to natural areas through the Forest Act and the Marine Areas (Preservation and Enhancement) Act. Under the Forest Act, forest reserves, game sanctuaries, and prohibited areas are designated, and terms and conditions for harvesting timber and wild fauna defined. In the Marine Areas (Preservation and Enhancement) Act, Buccoo Reef Marine Park is delimited. Wildlife is given some protection under the Conservation of Wildlife Act. Marine resources are given some protection under the Fisheries Act.

Natural resource management in Trinidad and Tobago has preserved biodiversity well even though the original intent of these early efforts were not so defined. In 1765, the Main Ridge Forest Reserve in Tobago was declared as a forest reserve "for the protection of the rains" and is reported to be the oldest forest reserve in the world dedicated to a specific environmental purpose. In Trinidad several forest reserves were established primarily for the preservation of flora, and some wildlife sanctuaries were set aside for the protection of fauna. In 1980, 62 sites were recommended as National Parks and Protected Areas. Most of these contain some unique flora and fauna. Current management is based on the precautionary principle. The lack of knowledge of Trinidad and Tobago's biological diversity precludes comprehensive management based on scientific data. Large areas are now "managed" by default, *i.e.* no removal of any material is allowed.

A chronic problem that has plagued Trinidad and Tobago is the general lack of appreciation of and concern for the country's biodiversity. Squatting and illegal logging in forest reserves continue, hunting goes on in and out of hunting seasons in wildlife sanctuaries, and mesh regulations for fishing nets are ignored. In general, enforcement is severely limited by lack of human and financial resources. Systematic and focused education on the environment within the school curriculum is limited, as are sustained public education and awareness campaigns on environmental issues. Draft legislation on national parks and wildlife and on fisheries has been prepared recently for public comment. Other significant events relating to the management of biodiversity include regulating squatting to contain the destruction of these unplanned developments, and removing rice farmers from the Nariva Swamp – a RAMSAR site.

Status of Species

Widespread concern continues to be expressed over the decline in numbers of some species and the extinction of others. Natural areas are being settled leading to increased stress on habitats. This particularly impacts the large game species, which require more space for maintaining viable populations. While many species maintain a tenuous existence in Trinidad and Tobago, confirmed extinctions are rare. The scarlet and the blue and yellow macaws, both widely distributed in the neotropics, are probably now locally extinct. Both species may, however, have been exotics introduced by Amerindians several millennia ago. Several of the non-game mammals are now confined to remote areas. One species of river catfish may be locally extinct. Several plant species, particularly those requiring special habitats, have also become rare. On the other hand, since the biota of Trinidad and Tobago is essentially South American, local extinction of a few wide-ranging species will not be a catastrophic loss to global diversity. The significance of such extinction would

be at the national level where the overall genetic pool would be reduced and altered and its benefit to the nation eliminated.

Data Collection and Information Management

Conservation and management of biological diversity assume scientific knowledge of the diversity of species, their assemblages and inter-relationships in communities, and their relationship to the natural environment supporting them. Scientific study of the biota of Trinidad and Tobago continues to be poorly supported and is directed largely through individual initiative. Much of the knowledge of the flora has originated from specialists working in metropolitan centers on material collected locally. Much of the knowledge of the fauna has been determined in this way although some noted contributions have come from resident naturalists. In contrast to the orderly study of the flora over the past 70 years, studies on the fauna have been biased toward vertebrates and insects without a national plan. The recent approval of funds for a National Biodiversity Strategy and Action Plan (NBSAP) as part of its implementation of the Convention on Biological Diversity will no doubt improve this situation within the next 2 years. This should contribute significantly to the coordination and structuring of research programs on the country's biological diversity.

BIBLIOGRAPHY

Kenny, J., P. Comeau, and L.A. Katwaru. 1997. Environmental Management Authority Data and Information Project: A survey of biological diversity, Trinidad and Tobago. Trinidad and Tobago.

BIODIVERSITY IN THE CARIBBEAN: CONCEPTS, ASSESSMENT, MANAGEMENT, AND MONITORING AT THE LANDSCAPE SCALE

Ariel E. Lugo and Sandra Brown

INTRODUCTION

The first Caribbean Foresters Meeting in 1982 focused on traditional forestry issues, including plantation forestry and forest protection (Brown and Lugo 1982). During the 9th meeting, some 16 years later, we discussed iguanas, toads, and endangered herbaceous plant species. A paradigm shift occurred since Caribbean foresters began to meet every other year to discuss the forestry issues that influence Caribbean forests. Paradigms dictate how we view the world and they influence our actions. Imagine taking a long boat ride under the paradigm that the Earth is flat!

Some examples of paradigm shifts in forestry include a greater focus on long-term processes as opposed to focusing on short-term views. In the Caribbean this is evident with the realization of the importance of hurricanes to forests. A single hurricane can unleash ecological processes that last decades. The volcanic explosions on the island of Monstserrat will influence the ecology of that island for centuries. Coincident with long-term views, forestry is also becoming more global in outlook. The intensity and frequency of hurricanes in the Caribbean, for example, might depend on El Niño phenomena that take place in the Pacific Ocean. No longer is it possible to explain ecological processes without considering global forces.

The subject of biodiversity is in itself a paradigm shift. Instead of the traditional views on species richness, we now focus on all the manifestations of life on earth. Biodiversity encompasses populations, species, ecosystem functions, and whole landscapes. Landscapes encompass the large-scale aspects of biodiversity and we will focus on them in this paper.

CARIBBEAN LANDSCAPES

Although Caribbean islands are small, their landscapes are diverse and complex. They contain complex topography and diverse soil types and support numerous ecosystem types from marine to coastal to montane. Biodiversity in Caribbean island landscapes is under enormous pressure. A dense population places different and persistent demands on the landscape. The result is that over the millennia of human habitation in the Caribbean, people have modified and transformed the original landscapes of the islands. Pre-Columbian inhabitants drove many animals to extinction, and post-Colombian people have greatly modified vegetation structure and composition and even the topography of the islands. Surprisingly, the landscapes of the Caribbean continue to function and support people in spite of the dramatic changes induced by human activity on their structure and composition. Resilience and resistance to disturbance are two fundamental characteristics of Caribbean landscapes, although they are also vulnerable.

THE CARIBBEAN IS A MODEL FOR THE FUTURE OF TROPICAL BIODIVERSITY

Much of the debate about tropical forest conservation centers on the high rate of deforestation and its consequences to biodiversity. Caribbean islands are ahead of the trends now being observed in the continental tropics. For example, the cycle of deforestation has already taken place on most Caribbean islands. Natural reforestation is occurring on many islands where agricultural fields have been abandoned due to the demise of sugar cane

cultivation in the region. Many people are also concerned about the invasion of tropical forests by alien species. In the Caribbean, however, many alien species have already been naturalized and now form part of the flora and fauna of the region. As a result, Caribbean landscapes contain many examples of new types of vegetation because the species composition is different from what it was in the pre-Colombian landscape. In fact, many sectors of the Caribbean landscape are dramatically different from the landscapes that sustained our ancestors.

The Caribbean portends the future because trends that are now beginning to develop in the mainland tropics have already been played-out on Caribbean islands. Caribbean-island landscapes can be used as models or harbingers of the future in the continental tropics. What we observe in the islands are old landscapes still in a constant state of change both in structure and composition. These landscapes are also in constant use by people and, fortunately, Caribbean landscapes continue to serve people well. However, there are events taking place in the Caribbean that we cannot explain and that are cause for concern in terms of the conservation of our biodiversity. Two examples of these events, which we call surprises because they are unpredictable and unexplained, are amphibian population decline and coral reef bleaching. These surprises highlight our ignorance and the unforeseen effects of human activity on biodiversity.

THE NEED FOR A NEW TYPE OF MANAGEMENT

Management is a way for people to allocate space for human activities without undermining the natural processes that sustain all life on earth. Caribbean landscapes require innovative management approaches for conserving their biodiversity because human activity is intense and could easily overwhelm the resilient mechanisms of its ecosystems. The term ecosystem management is used to describe a series of approaches that embody the new management paradigms based on ecological sciences.

The characteristics of ecosystem management that are particularly useful for application in the Caribbean are the following:

- its focus on long- as well as short-term, and large- as well as small-scale phenomena
- its flexibility and adaptive strategy in light of the constantly changing conditions of the region
- its focus on all the regions' biodiversity and all the regions' land
- its treatment of disturbances (natural and human) as critical components of Caribbean ecosystems
- its reliance on research for finding new solutions to problems and for monitoring the effectiveness of management activities.

Ecosystem management requires understanding environmental change and, in fact, it incorporates change as necessary to ecosystem function. Ecosystem management is based on the paradigm of resilience as opposed to the paradigm of fragility. However, it is understood that natural ecosystems are vulnerable to human activity.

Because of the fundamental role of biodiversity in sustaining human activity and life quality on earth, tropical forest managers are now in a position to lead the world in its search for sustainable human activity on this planet. Caribbean foresters in particular are uniquely poised to exert leadership on islands where the relationship between biodiversity and human activity is much more intimate than in the vast and sparsely populated continental areas of the world.

ASSESSING BIODIVERSITY

Assessing and monitoring biodiversity is time consuming and costly because much technical knowledge is needed as well as complex and lengthy field expeditions. Modern technology in the form of computer assisted Geographic Information Systems (GIS) and Global Positioning Systems (GPS) can aid and expedite the assessment and monitoring of biodiversity.

To fully utilize the power of GIS at the landscape level it is best to stratify the landscape into measurable units, identify areas undergoing rapid

change, identify vulnerable areas, and monitor human activities and impacts. This approach requires the use of multiple layers of information obtained using remote sensing techniques. Some of the more common ones are climatic data, soil types, land cover, and land use. Some of this information may be obtained from the worldwide web or from institutions such as government agencies, colleges, and non-governmental organizations.

Geographic information provides site-specific information that can be used with biodiversity information to increase understanding of how living systems respond to environmental change and variability. As an example, traditional measures of species richness can be correlated with rainfall (fig. 1), time after disturbance (fig. 2), or human disturbance (fig. 3). These correlations illustrate how tree species richness reflects the climate, age, or degree of human disturbance of forests. Over large areas (towards the right of fig. 3), human disturbance seems to have less impact - moderately disturbed regimes are similar in species richness to undisturbed sites. Such fundamental understanding can be used to extrapolate to whole landscapes using information on the geographic distribution of environmental factors. In addition to the factors mentioned, it is necessary to consider seasonality, soil type, slope, aspect, and previous human activity.

Using fundamental understanding of ecological relations such as those just discussed, it is possible to assess biodiversity at landscape, regional, or country levels. This involves overlaying land cover maps with maps depicting environmental factors such as life zones (a summary of climatic factors). This step results in climate/land cover classes that are unique ecological units with particular ecological characteristics.

These ecological units are useful for organizing field work and analysis. For example, large areas with similar life zones will have a different sampling scheme than large areas encompassing many life zones. In designing biodiversity assessments, areas of potential high species richness, high endemism, or special soil types should be identified. Areas requiring protection can be selected to include the diversity of ecological units on the landscape. This will result in a more diverse and representative network of protected areas. Areas where biodiversity is rapidly changing, for example, in locations with secondary forests or with rapid land-use changes, also need to be identified in biodiversity assessments.

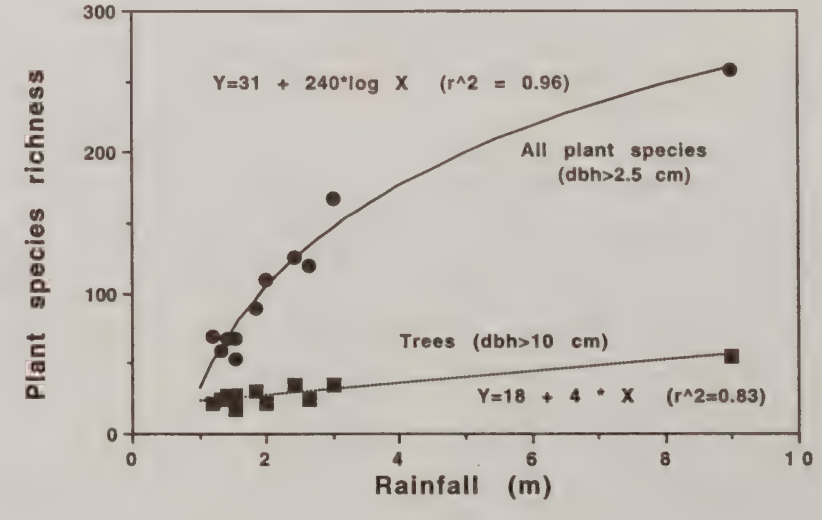


Figure 1. - Species richness vs. rainfall (Gentry 1982).

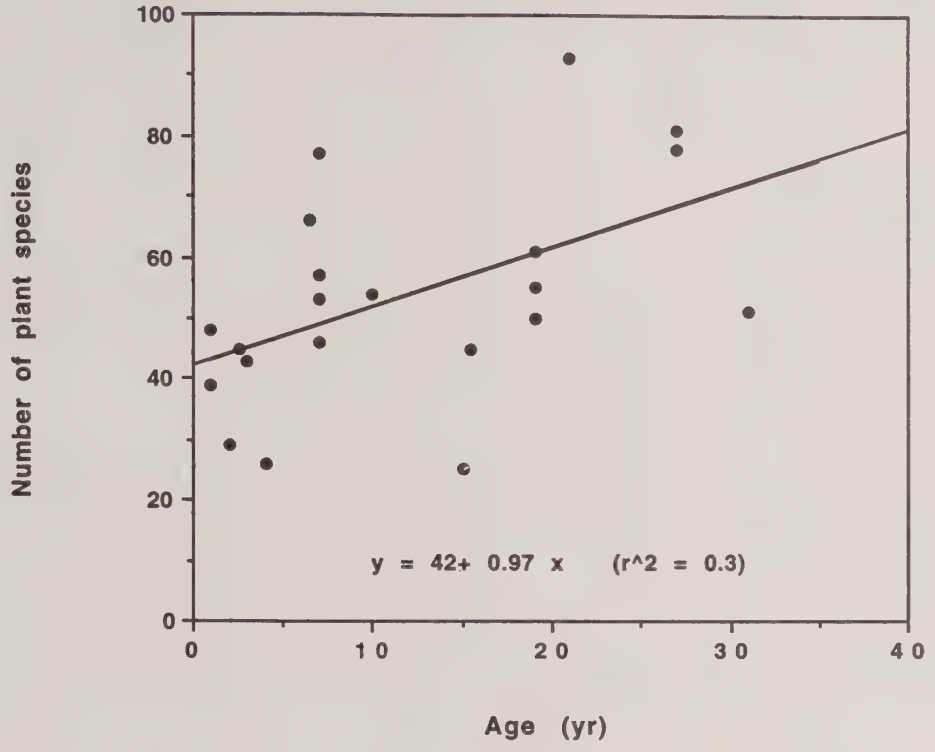


Figure 2. - Species richness vs. age (Lugo *et al.* 1993).

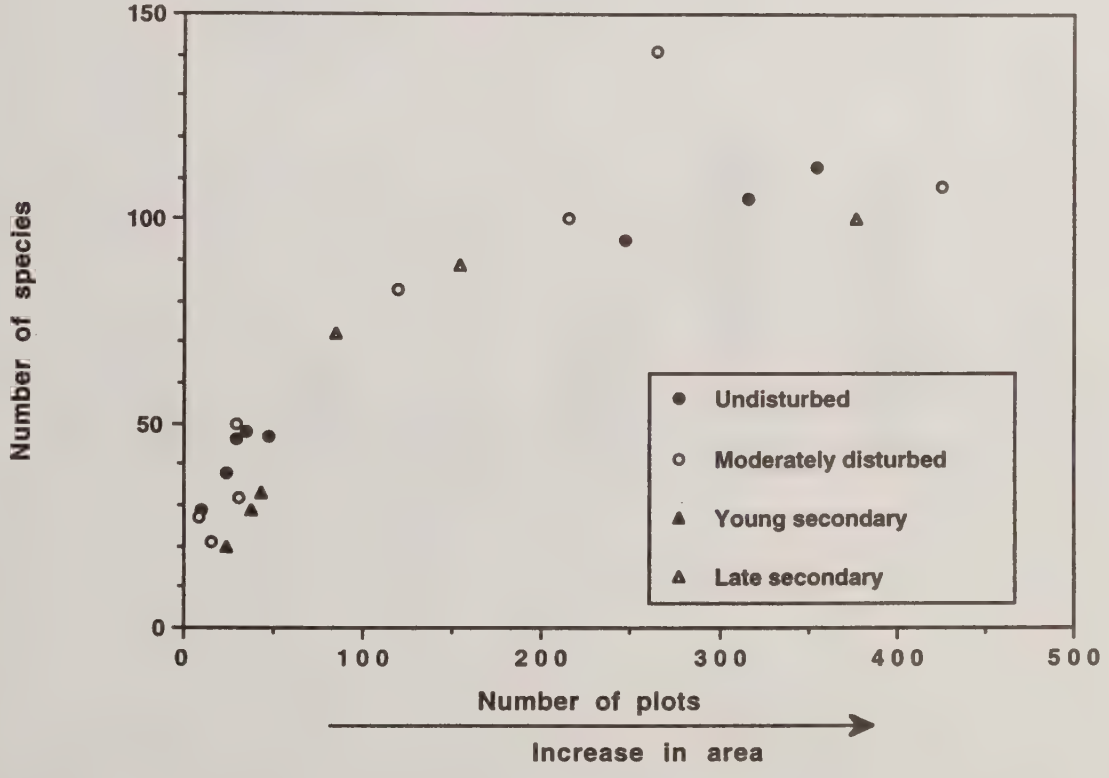


Figure 3. - Species richness vs. human disturbance (Lugo and Brown 1996).

These sites may need restoration activities or time to allow them to develop their full biodiversity potential.

MONITORING BIODIVERSITY

Biodiversity should be monitored in the context of those human activities that modify it the most. Examples of these human activities are those that change land use and land cover, situations where resource management has been deficient, actions that fragment the landscape by increasing the edge-effect, construction of roads and other corridors throughout the landscape, or establishing incompatible land uses adjacent to natural areas.

All these human activities and their effects on the landscape and its biodiversity can be monitored using GIS technology. For example, from maps it is possible to estimate the perimeter-to-area ratio of forest fragments. As perimeter-to-area ratio decreases, landscapes become less fragmented, a positive development for biodiversity conservation. Landscapes with a high fraction of edge may have more species at the edge, but their overall species richness decreases. Unfragmented landscapes are more favorable to biodiversity conservation, carbon sequestration, and to the overall function of natural systems. Humans tend to decrease the perimeter-to-area ratio of landscapes.

These general principles about the fragmentation of the landscape are illustrated in figures 4 and 5. From land use maps of the Guánica dry forest in Puerto Rico, we estimated the changes in the perimeter-to-area ratio between 1936 and 1989 for various land-use categories (fig. 4). Recovery towards closed forest was associated with reductions

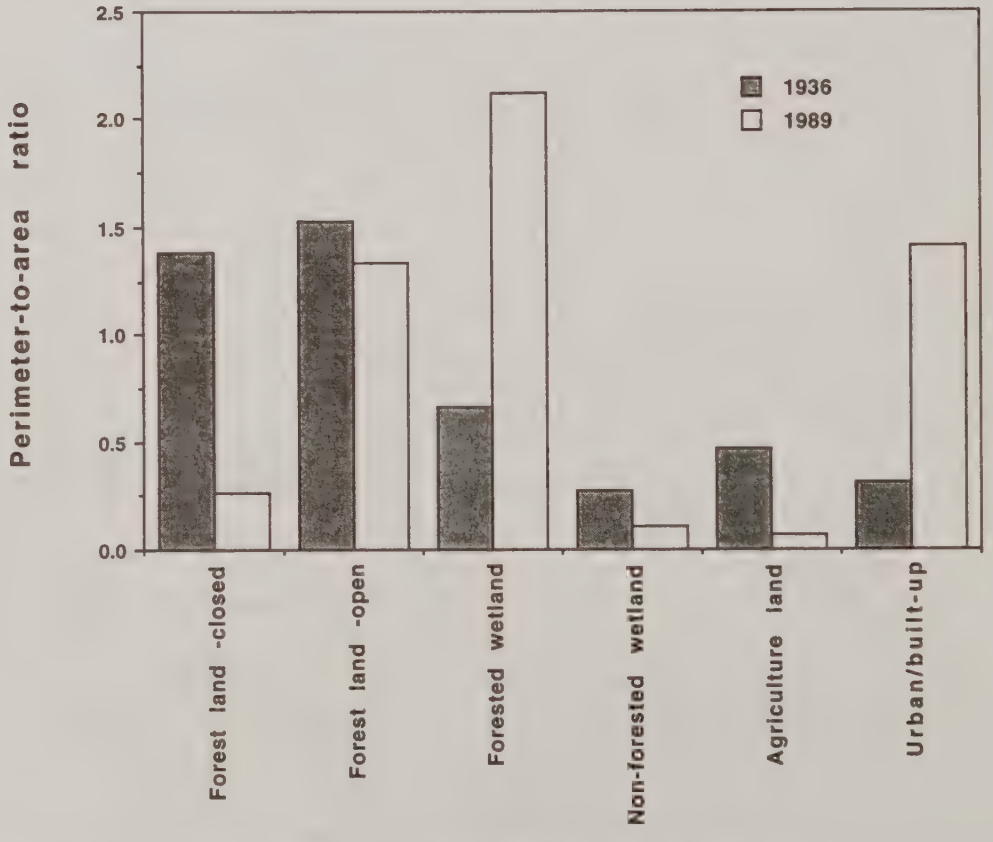


Figure 4. - Changes in perimeter-to-area ratios between 1936 and 1989 for various land cover types in the Guánica dry forest. Ratios were estimated from the land cover map in Lugo *et al.* (1996).

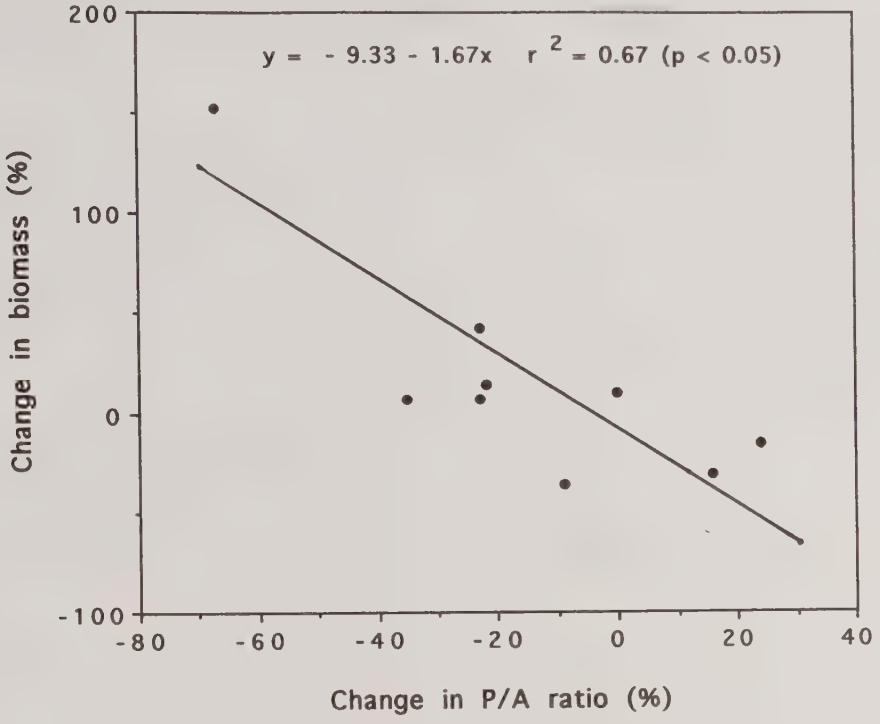


Figure 5. - Relation between change in perimeter-to-area ratio and change in biomass of forests in Peninsular Malaysia between 1972 and 1982. Data were estimated from biomass maps in Brown *et al.* (1994).

in the perimeter-to-area ratio, while urbanization had the opposite effect. In Peninsular Malaysia the changes in perimeter-to-area ratio were related to changes in biomass (fig. 5). A decrease in the perimeter-to-area ration means the forests are becoming less fragmented, resulting in more biomass. This suggests the forests are less accessible and are not being disturbed by humans. Those forests whose perimeter-to-area ratio increased became more fragmented, and biomass decreased, implying greater accessibility and greater disturbance and use by humans.

SUMMARY

Biodiversity conservation is a new paradigm of tropical forest conservation. It allows foresters to view the full spectrum of biological diversity from organisms to populations to communities to landscapes. Modern techniques of analysis, including GIS and GPS, allow foresters to assess landscapes from a biodiversity perspective and monitor the effects of human activities on landscape biodiversity. Risk is minimized by minimizing landscape fragmentation, which can be measured by the perimeter-to-area ratio. The location of human activities, such as roads, other corridors, and urban uses on a landscape, is also important to the function of the landscape, its composition, and biodiversity.

ACKNOWLEDGMENT

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LITERATURE CITED

Brown, S. and A.E. Lugo, editors. 1982. Forestry in the Caribbean. US MAB Report No. 7. US Man and the Biosphere Program, US State Department, Washington, DC. 137 p.

Brown, S., L. Iverson, and A.E. Lugo. 1994. Land use and biomass changes of forests in Peninsular Malaysia during 1972-82: use of GIS analysis. Chapter 4 in V.H. Dale, editor. Effects of land use change on atmospheric CO_2 concentrations: southeastern Asia as a case study. Springer Verlag, NY.

Gentry, A.H. 1982. Patterns of neotropical plant species diversity. Evolutionary Biology 15:1-84.

Lugo, A.E., J.A. Parrotta, and S. Brown. 1993 Loss of species caused by tropical deforestation and their recovery through management. Ambio 22(2-3):106-109.

Lugo, A.E., O. Ramos, S. Molina, F.N. Scatena, and L.L. Vélez. 1996. A fifty-three year record of land use change in the Guánica forest biosphere reserve and its vicinity. International Institute of Tropical Forestry, USDA Forest Service, Río Piedras, PR. 13 p + maps + photos.

Lugo, A.E. and S. Brown. 1996. Management of land and species richness in the tropics. Pages 280-295 *in* R.C. Szaro and D.W. Johnston, editors. Biodiversity in managed landscapes. Theory and practice. Oxford University Press, New York.

GROWTH AND ACCLIMATIZATION OF NINE FOREST SPECIES IN THE DOMINICAN REPUBLIC

Alberto Sánchez
in collaboration with
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ABSTRACT

The growth and acclimatization of nine species (*Acacia mangium, Azadirachta indica, Catalpa longissima, Cedrela odorata, Eucalyptus grandis, Pinus caribaea, Simarouba glauca, Swietenia macrophylla, and S. mahagoni)*, established either as line plantings or block plantations, were evaluated 18 to 44 months after planting in Tocoa, Dominican Republic. Different methods of planting did not result in marked differences in growth except for of *A. mangium* in dense, block plantations (*e.g.*, 2,667 trees/ha) where the initial rapid growth rate and the density of the stand led to reduced diameter growth at an early age. The mean annual increment in height and diameter of the trees on the best sites were *A. mangium* (4.25 m, and 3.95 cm), *E. grandis* (3.38 m and 2.54 cm), *S. macrophyla* (2.20 m and 2.31 cm), *S. mahagoni* (1.34 m and 1.26 cm), *A. indica* (2.06 m and 1.90 cm), and *S. glauca* (1.46 m and 1.57 cm). The mean annual increments in height of the poorly developed species were *P. caribaea* (0.23 m); *C. longissima* (0.81 m) and *C. odorata* (0.53 m). It is concluded that the growth of the nine species was influenced by soil conditions, maintenance practices (weed control, especially grasses), and the capacity of each species to acclimatize to extremely degraded soils. *A. mangium, E. grandis, S. glauca, S. macrophylla,* and *S. mahagoni* were the most promising species for reforestation under the conditions tested.

Keywords: growth, forest plantation, small farmers, degraded sites, Dominican Republic

INTRODUCTION

The Dominican Republic is considered to have a good potential for forestry development based on the productive capacity of its soils. The country, however, has not made significant advances in implementing sustainable forestry for the rural population. Although some official entities (*e.g.*, non-government organizations, the private sector, and international organizations) have initiated reforestation plans to counteract forest degradation, these attempts have been inadequate in that the soils continue to erode and residents in forested areas remain impoverished.

One recent positive initiative is the Line Planting Project financed by the International Institute of Tropical Forestry in Puerto Rico. The project, under the direction of Pronatura, was supported locally by field technicans of the US Peace Corps and Floresta, Inc. The project, designed to incorporate tree planting on the properties of small farmers, provides them with economic alternatives while reestablishing forest cover. Promising native and exotic species were planted in block plantations, in line plantings, or interspersed with subsistence crops (agroforestry).

Forest research in the Dominican Republic is in its initial stages. Currently, there is no national strategy for research or a system to disseminate technical information (*e.g.*, species behavior under different conditions, soil requirements, damage by insect pests and fungal diseases) to the field. This has resulted in the inappropriate selection of tree species for reforestation and has created false expectations on the part of farmers and individuals interested in promoting activities in the forestry sector.

To promote forestry research, we began a study to evaluate the growth potential of selected tree species using different planting techniques under various soil conditions. This information will be useful to farmers and forest managers interested in establishing forest plantations for profit.

MATERIALS AND METHODS

The study was undertaken in the community of Tocoa in Cotui county, located in the province of Juan Sánchez Ramírez. The geographic coordinates are 18° 54' N and 70° 11' W. Elevation on the planting sites ranged from 190 to 320 m. Precipitation averages 1,850 mm/yr and is well distributed; only 2 months have rainfalls less than 100 mm (Oficina Nacional de Meterología 1998). Mean annual temperature is 26.2 °C and varies from 20.7 to 31.8 °C. The area is located in the subtropical moist forest life zone (Unión Panamericana 1967) according to the Holdridge (1967) life zone system. The soils, situated on slopes ranging between 5 and 35 percent, are shallow and acidic. Past land uses included subsistence agriculture, pasture, and fallow. In general, all soils are seriously degraded by erosion.

The plantations, irregularly distributed on the properties of small farmers, were established in pure blocks (spacing 1.5x1.5 m to 2.5x2.5 m), in lines (spacing 1.5x1.5 m between plants and 10 m between lines), or in association with short-term crops (spacings same as in pure blocks). The species tested were *Acacia mangium, Azadirachta indica, Catalpa longissima, Cedrela ordorata, Eucalyptus grandis, Pinus caribaea, Simarouba glauca, Swietenia macrophyla,* and *S. mahagoni.* Fertilization and weeding were scheduled at regular intervals.

Fifteen permanent plots, varying in size and form, were established on three farms. All trees within each plot were tagged at eye level and numbered sequentially. The variables recorded on each plantation were plantation age, percent slope, spacing between trees and between lines, diameter at breast height (d.b.h.) in centimeters for trees taller than 1.5 m, and total height in meters. The conditions of the plantation and the property were also noted.

The analyses include mean diameters and heights and mean annual increment. ANOVAs (analysis of variance) at alpha = 0.05 were used to determine differences between species and among sites with the same species. When these differences were significant according to Duncan's multiple-range test, the fastest-growing species and the site conditions were described.

RESULTS AND DISCUSSION

Table 1 summarizes plot information including property owners, species, and planting techniques used, and the age of the plantings. Five farmers, with plantings ranging from 1.6 to 8 ha in size, cooperated in the program. The total area reforested was 14.8 ha. Table 2 summarizes percent slope, tree and line spacings, tree densities, plot basal areas, and mean annual diameter (d.b.h.) and height increments.

Growth Analysis for Each Species

Swietenia macrophylla

The growth of *S. macrophylla* in lines at Victor's farm was nearly three times that of the block plantation at Esteban's farm (fig. 1). Althouh all plants were fertilized and weeded, the sites are different. The line planting was situated at the base of a hill where the slope was less than 10 percent and the soil was deep. In contrast, the block plantation was located on a ridge where soil was compacted and degraded. The plantation at Lauterio's farm is located on deep soil in a ravine where growth should be optimal. Some trees are growing well. The terrain, however, is somewhat compacted and the site was not properly prepared for planting. No weeding was done and the trees were forced to compete with secondary brush. The incidence of attack by the shoot borer (*Hipsiphyla grandella*) was high, approaching 95 percent of the trees measured. This insect is common and infests trees up to a height of about 5 m.

Eucalyptus grandis

All sampled plantings of *E. grandis* were 36 months old. Mean annual increment in block plantations at Esteban's and Lauterio's farms was more than three times the growth of the line plantings

Table 1. - Farmers benefitting from project and descriptions of plantings[1].

Plot owner	Species	Age (mo.)	Type plantation	Area planted (ha)
Lauterio Hernández				
1	*E. grandis*	36	block	1.6
2	*S. macrophylla*	36	block	
Esteban Abad				1.6
3	*E. grandis*	36	block	
4	*C. longissima*	36	block	
5	*P. caribaea*	36	block	
6	*A. indica*	36	block	
7	*A. mangium*	18	block	
Victor Batista				2.2
8	*S. macrophylla*	36	block	
9	*E. grandis*	36	line	
10	*S. glauca*	44	line	
11	*S. mahagoni*	44	line	
12	*S. macrophylla*	44	line	
13	*A. mangium*	36	line	
14	*C. odorata*	44	line	
15	*S. mahagoni*	44	line	
José del Orbe[2]		—	—	1.6
Francis Vitoria[3]		—	—	7.8

[1]Data through date of measurement. Project is still underway with other cooperators in a second region.
[2]Project cooperator whose plantings were not measured. Species planted: E. grandis, S. macrophylla.
[3]Project cooperator whose planting were not measured. Species planted: *A. mangium, E. grandis, P. caribaea, S. macrophylla.*

at Victor's farm (fig. 2). Both block plantations, formerly in fallow, were located at the base of hills with slopes less than 15 percent. In contrast, the line planting, situated on a ridge, was recently in pasture. Although the slope was similar to those of the block plantations, the soil was shallow, less than 10 cm deep, and compacted by past grazing. Insufficient control of weeds (*e.g.*, *Melinus munitiflora*) also slowed tree growth.

Swietenia mahagoni

The two line plantings of *S. mahagoni*, established in similar soil conditions on Victor's farm, had similar growth rates (fig. 3). The slight differences in growth may be attributable to more effective weed control. In general, the growth rates are satisfactory when the early stage of development and the soil conditions are taken into consideration. *S. mahagoni* appears to be a promising species for this zone.

Acacia mangium

Both block and line plantings of *A. mangium* showed excellent initial growth but differences in plot ages complicate comparisons (fig. 4). Mean annual height growth in the block planting at 18 months on Esteban's farm was slightly greater than that of the line planting at 36 months on Victor's farm, possibly reflecting early competition for light. In contrast, mean annual diameter growth is significantly greater in the line planting at 36 months than in the block planting at 18 months. The latter

Table 2. - Growth of nine tree species at Tocoa, Cotui, Dominican Republic.

Plot[1] (no.)	Slope (%)	Spacing between trees (m)	Spacing between lines (m)	Density (trees/ha)	Basal area (m^2/ha)	Mean annual increment Diameter (cm)	Mean annual increment Height (m)
1	23	1.7	3.5	1,178	5.18	2.49	3.12
2	10	3.0	3.0	1,111	0.55	0.84	0.97
3	11	3.5	4.5	635	3.02	2.59	3.64
4	10	2.5	2.5	1,600	0.60	0.72	0.81
5	13	1.5	3.0	2,222	—	—	0.23
6	4	2.9	3.3	1,045	2.19	1.90	2.19
7	11	1.5	2.5	2,667	5.21	3.33	4.43
8	4	2.8	2.8	1,276	0.70	0.88	0.77
9	15	2.0	10.0	500	0.23	0.81	0.96
10	23	2.0	10.0	500	1.14	1.57	1.46
11	12	2.0	10.0	500	0.95	1.34	1.42
12	12	2.0	10.0	500	2.81	2.31	2.20
13	11	2.0	7.0	714	15.68	4.56	4.08
14	16	2.1	5.0	952	0.37	0.61	0.53
15	16	2.0	5.0	952	1.58	1.18	1.25

[1]Plot numbers same as table 1.

may be partially attributable to both the growth stage and the greater amount of available growing space in line plantings (table 2). The differences in diameter increment between 18 and 36 months might imply that wider spacings or earlier thinnings in block plantings would lead to more rapid early growth.

Analysis of Growth Differences by Species

Esteban's Farm

Of the five species planted on Esteban's farm, *A. mangium* grew the best and *P. caribaea* the poorest (fig. 5). *A. mangium* and *E. grandis* appear to be the most promising species on this site. The poor growth of *C. longissima* may be attributable to the shallow, acid soil which is generally infertile. Although the conditions appear adequate for *P. caribaea* (Sánchez 1992), its poor development may be due to the lack of mycorrhizae or improper tending.

Victor's Farm

Despite the generally poor conditions of Victor's farm, four of the six species tested, *A. mangium, S. macrophylla, S. glauca,* and *S. mahagoni*, showed satisfactory growth (fig. 6*). A. mangium*, growing twice as fast as the second most successful species, *S. macrophylla*, again showed its capacity to adapt to the poor soils in the region. The slow growth of *C. odorata* is probably due mainly to poor soils and, to some extent, insufficient weeding.

S. macrophylla grew about twice as fast as *S. mahagoni* but the latter appeared to suffer less damage by the shoot borer. *S. glauca* appears to grow satisfactorily in steep, eroded terrain, and in competition with pasture grasses, which impede the growth of most tree species (Sánchez 1994).

CONCLUSIONS AND RECOMMENDATIONS

Based on the above observations the authors arrived at the following conclusions

- Line planting and block plantations are satisfactory techniques for the establishing of commercial tree species.

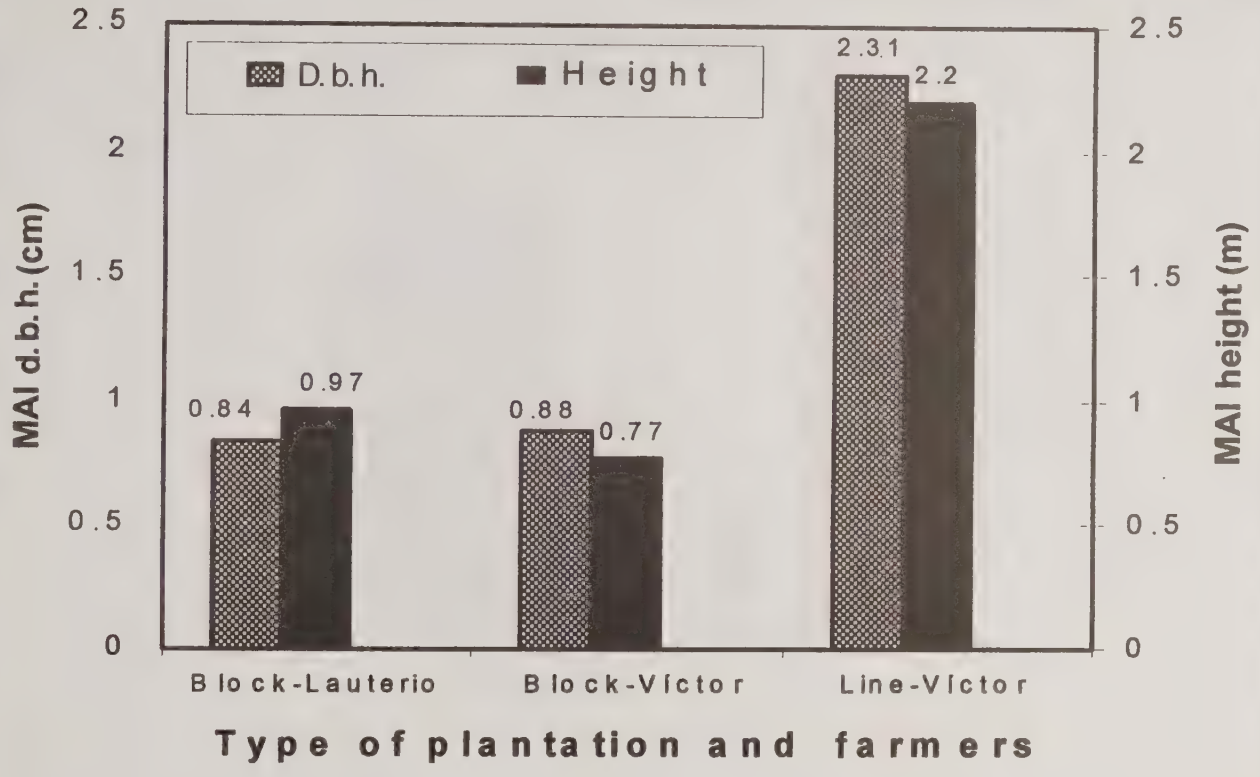

Figure 1. - Mean annual diameter and height increment in three plantings of *Swietenia macrophylla* at Tocoa, Maimón: block plantations after 36 months on Lauterio's and Esteban's farms; line planting after 44 months on Victor's farm.

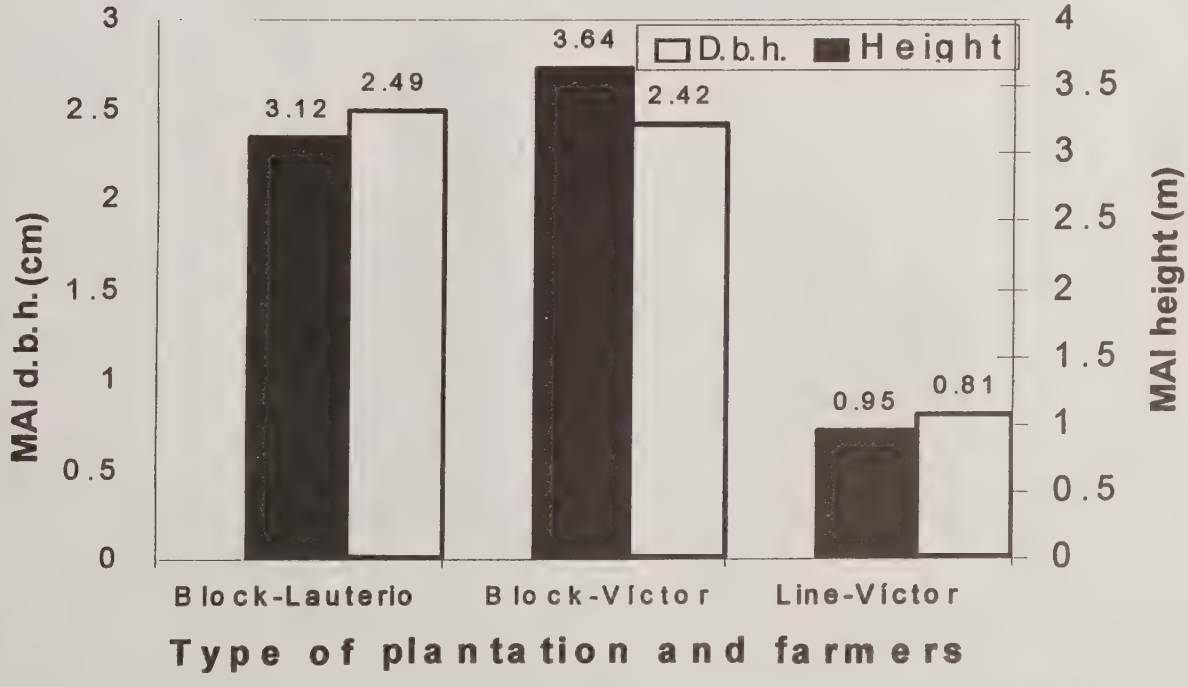

Figure 2. - Mean annual diameter and height increment in three plantings of *Eucalyptus grandis* after 36 months at Tocoa, Cutuí.

Figure 3. - Mean annual diameter and height increment in two line plantings of *Swietenia mahagoni* after 44 months at Tocoa, Cotuí.

Figure 4. - Mean annual diameter and height increment in two plantings of *Acacia mangium* at Tocoa, Cotuí: block plantation after 18 months at Esteban's farm; and line planting after 36 months on Victor's farm.

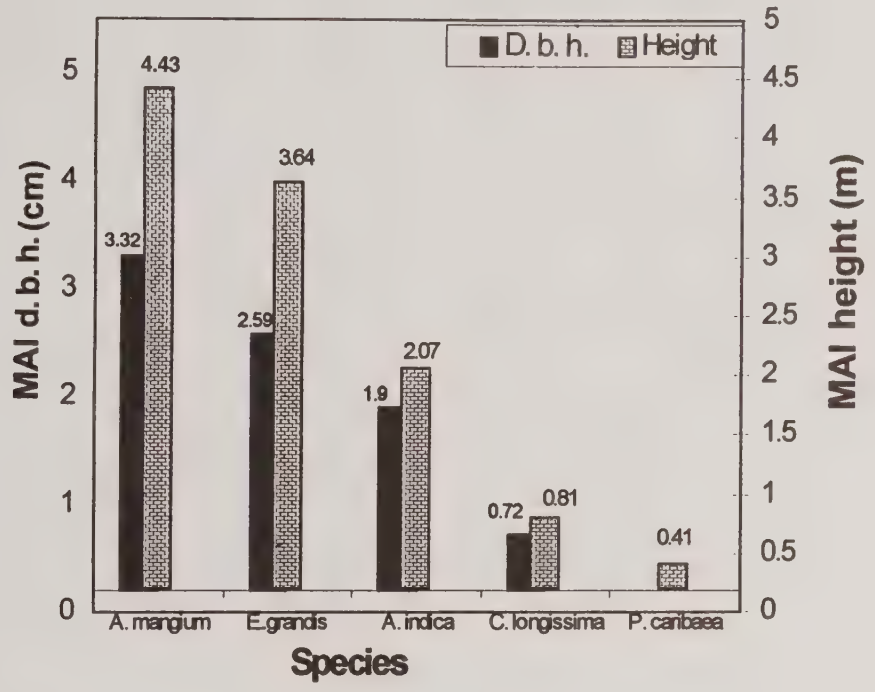

Figure 5. - Mean annual diameter and height increment of five species established in block plantations at Estaban's farm in Tocoa, Cotuí.

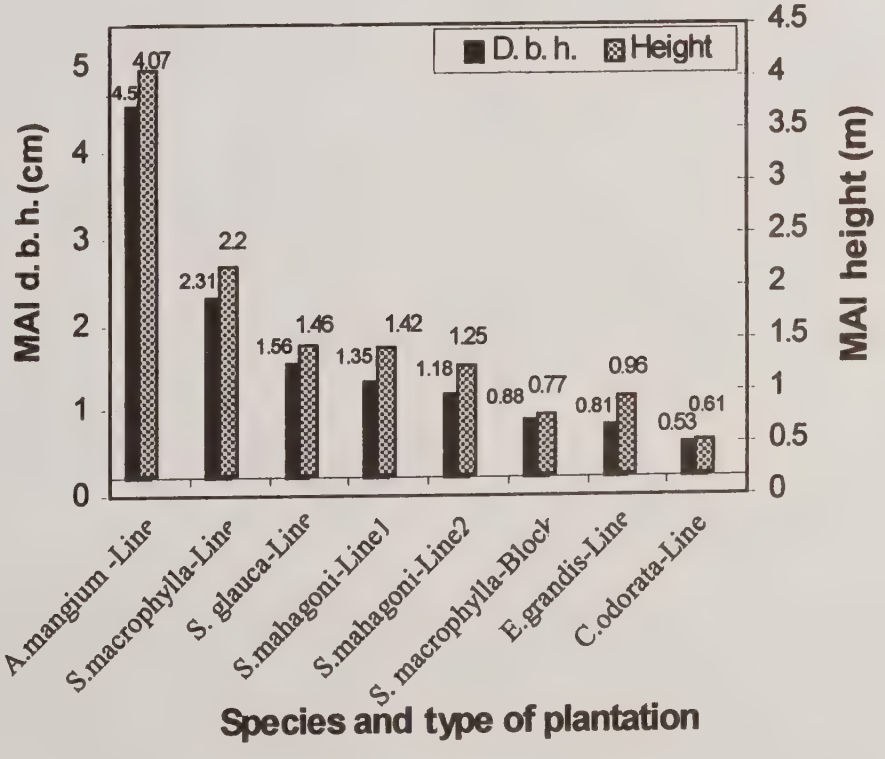

Figure 6. - Mean annual diameter and height increment of six species at Esteban's farm, Tocoa, Cotuí.

- Differences in growth rates appear more related to site conditions and management practices than establishment technique.
- Among the species tested, *Acacia mangium, Eucalyptus grandis, Simarouba glauca, Swietenia macrophylla* and *S. mahagoni* have the best potential for growing tree crops on diversified farms.
- Site quality, land preparation, and plantation maintenance appear to be the key limiting factors in the growth of some species.
- Provenances probably play an important role in growth and acclimatization, but data are insufficient to verify this hypothesis.
- Including a tree planting program appears to be a viable alternative for small farmers interested in producing a commercial tree crop while restoring badly eroded soils.

Recommended future activities include (1) physical and chemical analyses of soils to determine more precisely the limining factors for the establishment of each species, (2) provenance selection, careful site selection, and better tree maintenance to help identify additional promising species, and (3) continued observation of the permanent plots for at least 5 years to determine the dynamics of each species and to observe the increase in biodiversity on sites where plantings have been established.

ACKNOWLEDGMENTS

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LITERATURE CITED

Holdridge, L.R. 1967. Life zone ecology. Tropical Science Center, San José, Costa Rica. 206 p.

Oficina Nacional de Meterología. 1998. Regístro meterológico de República Dominicana. República Dominicana. (pages not numbered).

Sánchez, A. 1992. Inventario forestal de las plantaciones adultas de *Pinus caribaea* en el Proyecto Novillero, Villa Altagracia, R.D. Santo Domingo, República Dominicana. 73 p.

Sánchez, A. 1994. Crecimiento de *Eucalyptus grandis* y *Eucalyptus deglupta* en tres sistemas de plantación en Turrialba, Costa Rica. Tesis MSc. CATIE, Turrialba, Costa Rica. 95 p.

Unión Panamericana. 1967. Reconocimiento y evaluación de los recursos naturales de la República Dominicana. OEA, Washington, DC. 540 p. + anexos y mapas.

FOREST RESOURCES ASSESSMENT 2000 IN THE CARIBBEAN REGION

K. D. Singh and A. Marzoli

INTRODUCTION

This paper presents material on the FAO Forest Resources Assessment of the Caribbean Region. The first part reviews the information collected in the FAO Forest Resources Assessment 1990. The second part outlines features of Forest Resources Assessment 2000, which emphasizes in-country capacity building to perform assessments. The aim will be to assist countries in preparing country 2000 reports, describe the current status of forest resources, and evaluate the existing institutional and human resources needed to undertake assessment on a continuing basis.

Complementary to forest resources information, national production and consumption data will be collected within a project sponsored by the European Union. A workshop will be organized and training support provided to countries to enable them to obtain a balanced picture of the forestry sector and take appropriate action toward the conservation and sustainable management of forest resources.

DEFINITIONS

Like many geographic terms, Caribbean Region has been defined in various ways. This paper uses the term the Greater Caribbean (table 1), which includes three country groups: Caribbean Islands (also termed the Insular Caribbean), Central America and Mexico, and South American Caribbean (Lugo *et al.* 1981).

The term "forest" is used here to include all vegetation formations with a tree crown cover of at least 10%. This is the standard definition accepted by the meeting of experts held at Kotka, Finland, organized to lay down broad terms of reference for FAO Forest Resources Assessment 2000 (FAO 1998).

FOREST RESOURCES ASSESSMENT 1990

During 1989-93, FAO reviewed the forest resources information in the sub-region and produced the available information in the form of country briefs and a sub-regional synthesis in tables. These tables contain standardized country figures obtained by re-appraising the country information according to the definition, classification, and reference date accepted for the global assessment. The tables contained the following information:

- socio-economic data
- state of forest inventory
- area of natural forests and plantations
- forest area change during 1981-90
- forest harvesting
- land area and forest cover by ecological zone
- area of forest formations
- 107 annual deforestation during 1981-90 by forest formations

The results were published in FAO Forestry Paper 112 entitled *Forest Resources Assessment 1990: Tropical Countries*. A global database called FORIS has also been established with a view to updating country data when a country conducts new inventories. Country Briefs have been prepared giving forest resource information by country extracted from FORIS (FAO 1994). A synoptic view of forest cover by country by the end of 1990 is given in table 1.

A REVIEW OF COUNTRY CAPACITY IN FOREST RESOURCES ASSESSMENT

An important finding of FRA 1990 relates to country capacity, which formed the basis for drafting the recommendations in Section D: Combating Deforestation of Agenda 21, Chapter 11. Table 2 shows the relevant results from table 2 of FRA 1990 (viz. State of Forest Inventories) for the Caribbean sub-region.

Table 1. - Forest areas in countries of the Greater Caribbean (United States not included).

Country	Land area (000's ha)	Percentage forested (estimated from various sources)			Forest area (000's ha)
		Zon and Sparhawk	Persson	FAO	FAO-FRA90
		Date of Inventory			
		1920's	1970's	1990	1990
Central America					
Belize	2,280	75	87	88	1,996
Costa Rica	5,106	75	43	28	1,428
Guatemala	10,843	65	60	39	4,225
Honduras	11,189	80	63	41	4,605
Mexico	190,869	23	35	25	48,586
Nicaragua	11,875	71	49	51	6,013
Panama	7,599	60	54	41	3,117
Subtotal	**239,761**				**69,970**
Weighted Average		**32**	**39**	**29**	
South America					
Colombia	103,870	54	68	52	54,064
Guyana	19,685	87	85	94	18,416
Suriname	15,600	90	91	95	14,768
Venezuela	88,205	41	53	52	45,690
Subtotal	**227,360**				**132,938**
Weighted Average		**54**	**65**	**58**	
Insular Caribbean					
Antigua	44	-	-	23	10
Bahamas	1,001	13	28	19	186
Barbados	43	-	-	0	0
Cuba	10,982	46	14	16	1,715
Dominica	75	-	-	59	44
Dominican Republic	4,838	77	23	22	1,077
Grenada	34	-	-	18	6
Guadeloupe	169	12	38	55	93
Haiti	2,756	60	7	1	23
Jamaica	1,083	30	45	22	239
Martinique	106	-	25	41	43
Montserrat	10	-	-	30	3
Netherland Antilles	80	-	-	0	0
Puerto Rico	886	20	17	36	321

Table 1. - cont'd.

Country	Land area (000's ha)	Percentage forested (estimated from various sources)			Forest area (000's ha)
		Zon and Sparhawk	Persson	FAO	FAO-FRA90
		Date of Inventory			
		1920's	1970's	1990	1990
Saint Kitts-Nevis-Anguilla	36	-	-	36	13
Saint Lucia	61	-	-	8	5
Saint Vincent	39	-	-	28	11
Trinidad and Tobago	513	59	46	30	155
Virgin Islands (UK)	15	-	-	27	4
Virgin Islands (US)	34	-	-	0	0
Subtotal	**22,805**				**3,948**
Weighted Average		**50**	**18**	**17**	
Total	**489,926**				**206,856**
Weighted Average		**44**	**51**	**42**	

Table 2. - Actual status of resource assessment inventories.

Number of Caribbean countries reported	31
Number of countries with two or more inventories	7
Number of countries with a single inventory	24
Countries with no updates after 1980	17
Number of countries with inventories conducted after 1980	14

Source: FAO FORIS database.

In terms of quality and comprehensiveness, the findings were rather disappointing. The following general observations in FRA1990 report for the tropical zone apply equally to the Greater Caribbean countries:

- The completeness and quality of the forest resources information vary greatly among regions and countries within a region, with Asia faring better than tropical America and the latter better than tropical Africa.
- The timeliness of the information also varies greatly. The data average about 10 years old, which could bias the assessment of change.
- The countries have not used the most appropriate techniques, such as Continuous Forest Inventory designs, for change assessment.
- Only a few countries have reliable estimates of actual plantations, harvest, and utilization, although such estimates are essential for planning and policy-making for sustainable forest management.
- No country has carried out a national forest inventory producing information that can be used to generate reliable estimates of the total woody biomass and change. (Puerto Rico may be an exception.)
- Links between forest resources assessment and planning are generally weak or non-existent; information is produced in isolation from its application. In other words, existing information is poorly used and insufficient feed back from users reaches the producers of information.

These observations raise a fundamental question about capacity building in forest resources assessment. Capacity building and support for assessments will not serve a useful purpose until a country has an effective planning and control institution. Only then, will forest inventories serve a useful purpose.

FAO FOREST RESOURCES ASSESSMENT PROGRAMME

In response to UNCED Agenda 21, related to assessment and periodic evaluation of forest resources, FAO developed a comprehensive Forest Resources Assessment Program for country capacity building and global forest resources assessment. The Country Capacity Building component consists of two main elements: strengthening the country capacity to conduct surveys/studies for effective planning and control of national forestry sector on a continuing basis; and expanding the scope of national forest inventories and planning to include important forestry parameters relevant to environmental change, such as biomass, biological diversity, and land degradation

The Global Forest Resources Assessment component includes two major activities: assessment of the state of forest resources and their change on the global/regional/sub-regional levels, based on existing reliable information from countries for the reference year 2000, and assessment of state of forest resources and trends using multi-date remote sensing on a sampling basis with global/regional/sub-regional coverages.

Major effort is made to develop a synergy between the global assessments and country capacity building components. In fact, the Country Capacity Building is being seen as the driving force to provide reliable data to the international community.

GLOBAL FOREST RESOURCES ASSESSMENT 2000

The Global Forest Resources Assessment 2000 has the following objectives:

- Assess forest resources (including information on the goods and services provided by forests) on a global basis with participation member countries.
- Estimate the changes in forests that have taken place since the last assessment and compare these with the results of all past assessments to establish trends.
- Provide information that helps understand the reasons for and the effects of change, including the social, economic, and environmental implications.
- Disseminate results, databases, and methodologies to interested national and international institutions world-wide.
- Contribute to country capacity building in forest resources assessment.

The FRA 2000 follows closely the design of the 1990 assessment. The international forestry community participated in this planning through a series of meetings, culminating in the "Expert Consultation on Global Forest Resources Assessment 2000" (Kotka III) held in Kotka, Finland, during June 1996. Forest inventory experts from all regions of the world, international and national organizations, non-governmental organizations, and individuals participated in the planning process. The FRA 2000 assessment has six major themes (FAO 1998):

- forest and land cover estimates (status as of 2000 and change)
- biological diversity
- economic potential of forests
- sustainable forest management
- carbon cycling
- country capacity building

Around these major themes, a preliminary set of core outputs has been defined (table 3).

Table 3. - Thematic elements for the global forest resources assessment 2000.

Forest and land cover estimates — Status as of 2000 and change
Forest and land cover areas by country
Global forest and ecoregional zone maps
Forest and land cover areas by ecofloristic zone
Change matrices depicting forest and land cover changes through time
Estimates of tree volume
Biomass estimates and biomass flux for forest and other land cover
Estimates of the area of forests and other wooded lands burned
Biological diversity
Area estimates of forest and other wooded lands by IUCN protection categories
Change matrix depicting changes in forest and other wooded lands in protected areas
Area estimates of forest by category of naturalness
Statistics on forest fragmentation
Economic potential of forests
Area estimates for forest available and not available for wood supply
Volume estimates of fellings
Descriptions and information on supply, demand, value, and quantity of non-wood goods and services
Area estimates of forest by ownership categories
Sustainable forest management
Information gathered from the other programme elements or special studies may allow the analyses of indicators of sustainable forest management, at least on a pilot basis.
Carbon cycling
Information gathered principally from the programme element on "Forest and Land Cover Estimates — Status 2000 and Change" and from remote sensing may be used to derive important information regarding carbon cycling.
Country capacity building
Bolster countries ability to acquire their own assessments of forest resources and use these results in developing national policies and strategies.

PARTNERSHIP: AN ESSENTIAL REQUIREMENT FOR EFFECTIVE GLOBAL ASSESSMENTS

Given the ambitious scope of and expectations for FRA 2000, a decentralized, partnership approach must be taken. Country correspondents have been key links in past assessments by promptly obtaining reliable data. This approach is continued and expanded for FRA 2000. In addition to furnishing data, countries are being encouraged to work together on a regional basis (TCDC) to help build country capacity through mutual support and, where possible, to carry out such activities through regional consultations and training courses and bilateral co-operation in data acquisition, compilation, and

analyses. Some ideas are presented in annex 1. The idea is to establish mechanisms through which member countries, especially the developing ones, will be providers as well as users of the information gathered within the framework of the Global Forest Resources Assessment 2000. The need for country and global assessments and the information they provide will continue beyond 2000. It is hoped that country capacity building will provide better data for global assessments but, more importantly, that they will enable countries to produce information for their own planning and control. It may be useful to end this paper with the concluding paragraph of the first World Forest Inventory in 1948: "All these investigations made valuable additions to our knowledge, but all suffered from certain fundamental difficulties. Most important of these were the lack of reliable forest inventory information which existed and still exists in many countries, and the lack of commonly accepted definitions of some of the more important forestry terms. Hence, to the weakness of some of the quantitative estimates there was added doubt as to the real meanings of some of the qualitative descriptions."

This statement remains largely true today, almost 50 years later. To reach the ultimate goal of a global assessment based on reliable country-by-country data, there needs to be a foundation of sound national forest resources information. To ensure this requires an all-out effort to increase capacity, especially in the tropical region. More importantly, this within-country capacity is needed so that individual countries can plan for the appropriate use and management of their own forests.

REFERENCES AND BIBLIOGRAPHY

FAO. 1993. Forestry resources assessment 1990: Tropical countries, FAO Forestry paper 112. FAO, Rome. 59 (plus 24 tables).

FAO. 1994. Forestry resources assessment 1990: Country briefs, 294. (This data is now being put on web site).

FAO. 1995. Forestry resources assessment 1990: Global synthesis FAO Forestry Paper 124. FAO, Rome. 44.

FAO. 1995. Forestry resources assessment 1990: Tropical forest plantation resources, FAO Forestry Paper 128. FAO, Rome. 81.

FAO. 1996. Forestry resources assessment 1990: Survey of tropical forest cover and study of change processes. FAO Forestry Paper 130. FAO, Rome. 152.

FAO. 1997. Forest resources assessment 2000: terms and definitions. FAO, Rome.

FAO. 1998. Global forest resources assessment 2000. FAO, Rome.

Lugo A.E., R. Schmidt, and S. Brown. 1981. Tropical forests in the Caribbean, Ambio 10 (6)

ANNEX 1

FOREST RESOURCES ASSESSMENT 2000 IN THE CARIBBEAN REGION

(Outline of a cooperative project between FAO Forest Resources Assessment Program, International Institute of Tropical Forestry and countries of the region)

Objective

There are two closely related aims: contribute to capacity building in forest resources assessment in the region, and provide inputs for FAO global FRA 2000.

Approach

In FRA 1990, FAO used two approaches: assessment based on existing statistical and cartographic data, and assessment based on new data (obtained from interpretation of multi-date satellite images).

Assessment Based on Existing Data

The need for global results has been defined by the team of international experts that met at Kotka, Finland, in June 1996. At the regional level, the reporting ambitions will be higher than at the global level and include parameters relevant to the perceived problems/needs in the region. Further work needs to be done to produce tables and maps to satisfy the region-specific needs of the information/report. Countries and IITF could make major contribution to this process.

The starting point of assessment is preparation of a catalogue of existing data (maps, forest inventories, human censuses and any other related data on socio-economic and ecological factors. A meta-database of all the available reports is needed with a brief annotation of their content (*e.g.* forest area, volume, harvesting, *etc.*) and with an indication of their reliability. This will require a visit to libraries of IITF, Oxford, and CIRAD-FORET.

Following FRA 1990, the database could be divided into the following:

1. Cartographic data
   - base-map at 1:250,000 scale for the whole region showing broad topographic features, national and sub-national boundaries, and important watersheds
   - eco-floristic (or life zones) based on a synthesis of existing maps (Beard, Holdridge, *etc)*
   - vegetation/land-use map based on existing country maps
   - demographic data in a time-series form (1950 or 1900 onwards) on a sub-national basis
2. Statistical database

This will include all parameters agreed at Kotka, Finland, June 1996 and others relevant to the Caribbean Region (yet to be decided). This database should be designed so it can be updated as and when new data for a field (*e.g.* forest cover for a country) becomes available. More emphasis needs to be placed on building of a database, by country/sub-national units, than on producing tables or results. This will have utility for beyond FRA 2000. IITF's GIS/RS Unit can facilitate this task.

Assessment Based on New Data

As in FAO FRA 1990, a new multi-date assessment of forest cover and land-use change, in the form of a change matrix, could be an interesting output. This work, however, would take time if the whole region is covered. As a compromise, this phase of work could be carried out in selected islands only. A representative selection of islands, based on stratification of all islands in the region, needs to be made.

Estimated Resources Needs for the Assessment

Based on Existing Data

Two types of tasks are involved: securing agreement/cooperation of interested parties/donors, and outlining the database and report. The available database is spread over libraries in many countries. It will be important to secure agreement of concerned institutes/countries to release the information. This job could be best done by FAO.

Countries and IITF together should jointly prepare a paper outlining the scope of FRA 2000 in the sub-region at the forthcoming meeting of Caribbean Foresters. This will facilitate the cooperation among countries in the assessment process. Technical work (*e.g.* database compilation/ GIS) could be done by Senior Experts (2m/m) and Junior Experts (24 m/m).

Besides the expert tasks, the support of the GIS lab of IITF will be required to digitize maps and organize them into a database. Most such jobs could also be contracted. IITF, as a lead center, will undertake most of the tasks; FAO could assist by providing support in form of 1 m/m of a Senior Expert.

Based on New Remote Sensing Data

- procurement of multi-data images for selected islands (5-6) (covering about 6-10 million ha land area)
- interpretation and digitizing at: 1:100,000 scale
- travel/other costs
- training in monitoring method (this could be done by FAO)

Using the overall approach developed by FAO FRA 1990 this will produce an important database for forest/land-use policy making.

Time Frame

The results of assessment based on existing data are needed before mid-1999 to provide input at Global FRA 2000.

CONSERVATION OF CARIBBEAN WILDLIFE DIVERSITY: THE ROLE OF AGROFORESTRY PLANTATIONS

Joseph M. Wunderle, Jr.

INTRODUCTION

Caribbean foresters accustomed to traditional concerns of plantation forestry, timber production, watershed protection, and reforestation are now faced with new challenges as they are asked to conserve biodiversity. Forest managers are being asked to conserve biodiversity because of the growing recognition of its many values. For wildlife, the value of diversity depends upon the recognition that (1) wildlife may form part of the national heritage, (2) wildlife diversity is an important attraction for ecotourism, (3) certain kinds of wildlife are a source of food and recreation, and (4) wildlife populations are integral components of biotic communities where they can make valuable contributions to seed dispersal, plant pollination, and decomposition.

Conserving wildife diversity presents tremendous challenges to Caribbean forest managers. These challenges include (1) the vulnerability of island wildlife to extinction, (2) the high proportion of endemic species, (3) habitat loss and degradation, and (4) forests are some of the most important habitats for threatened Caribbean wildlife. Despite these challenges, foresters are well acquainted with some of the means for conserving wildlife diversity, particularly when certain types of agroforestry plantations are considered. For example, recent studies indicate that some agroforestry plantations, such as traditional shade coffee plantations, can provide valuable habitat for forest wildlife. Thus, in this article I will summarize the characteristics of shade coffee plantations that make them attractive to wildlife. The results of our coffee studies are relevant to other plantations, such as cacao and nutmeg, which can also provide habitat for forest wildlife. This review emphasizes the importance for forest wildlife of keeping tree cover on agricultural landscapes, particularly as buffer zones surrounding forest reserves.

COFFEE BACKGROUND

It is well known among birdwatchers that traditional shade coffee plantations, in which coffee is cultivated beneath an overstory of shade trees, are good places to find birds. These plantations appear to mimic the structure of native broadleaf forest in which coffee makes up the understory shrub layer, often mixed with some bananas and plantains with the occasional avocado, citrus, or mango tree in the mid-story. The closed-canopy overstory is usually composed of one or more species of leguminous trees, often a species of Guamá or Guaba (*Inga* spp.), immortelle (*Erythrina* spp.), or quick-stick (*Gliricidia* spp.). Thus, for some wildlife, the vertical distribution of foliage may superficially resemble some broadleaf forests with a well-developed shrub understory and a closed canopy overstory.

Recently, interest has emerged in the potential conservation value of these plantations, which appear to provide habitat for forest-dwelling species (Perfecto *et al.* 1996, Rice and Ward 1996, Rice *et al.* 1997). The potential for shade coffee plantations to provide a "refugia" for forest dwellers was first recognized by Brash (1987), who stated that shade coffee plantations may have harbored many forest species during a period of extreme deforestation on the island of Puerto Rico, thereby limiting the expected loss of species due to deforestation. Therefore, shade coffee plantations may be particularly important for providing habitat for forest-dwelling species in deforested regions of the tropics.

Unfortunately, the current trend in coffee cultivation is to eliminate the shade overstory as farmers convert to higher yielding coffee grown in open sunlight (Perfecto *et al.* 1996). This "sun coffee" does not support the forest species commonly found in traditional shade coffee plantations (Borrero 1986; Greenberg *et al.* 1997a, 1997b; Wunderle and

Latta 1996) and requires more fertilizers and pesticides (Greenberg 1994, Rice and Ward 1996, Vannini 1994, Wille 1994). The ecological implications of this change in coffee cultivation are especially important in northern Latin America and the Caribbean, where coffee plantations cover about 2.7 million ha at mid-elevation sites that have already been extensively deforested (Rice and Ward 1996).

RESEARCH SUMMARY

Below I summarize our recent research in coffee plantations, which has implications for conservation of wildlife diversity in other agroforestry plantations.

Why are Birds Attracted to Shade Coffee Plantations?

Our studies (Wunderle and Latta 1998) of avian foraging in shade coffee plantations with an overstory of *Inga vera* (Mimosoideae) in the Dominican Republic indicate that most avian foraging occurs in the *Inga* overstory (65% of all observations) in contrast to the coffee where relatively little foraging was observed (9% of observations). Of 19 bird species studied intensively, 8 species (42%) foraged exclusively in the overstory canopy or subcanopy. Eighteen of the 19 species had a median foraging height significantly above the median maximum coffee height (fig. 1). No species foraged exclusively in coffee, but one insectivorous species (narrow-billed tody, *Todus angustirostris*) foraged mostly in the coffee. Thus, our study and those of Greenberg *et al.* 1997a, 1997b in Mexico and Central America indicate that the characteristics of the shade overstory, and not the coffee, are most important for attracting birds into plantations.

What Types of Birds are Attracted to Shade Coffee Plantations?

Various studies of birds in coffee plantations (Wunderle and Latta 1996, 1998; Greenberg *et al.* 1997a, 1997b; Wunderle, in press) indicate that the characteristics of the shade overstory are the major factors influencing the types of birds attracted to the plantations. In plantations with an overstory of *Inga* spp. or *Erythrina* spp., the flowering of these trees attracts numerous nectarivorous birds. As a result, plantations with these tree species are characterized by a large proportion of nectarivorous bird species. Insectivorous species are abundant also, and feed on insects and spiders on the surface of *Inga* leaves or among the leaves of various epiphytes. The pods of the *Inga* are consumed by parrots and parakeets as well as other species.

In addition to a predominance of nectarivorous bird species in shade coffee plantations, there are also forest-dwelling species. From a wildlife conservation viewpoint, this is the most important aspect of shade plantations. The potential for attracting some forest-dwelling species is strong as we have shown that some forest species use shade coffee plantations (Wunderle and Latta 1996). The shade plantations are characterized by a predominance of forest or woodland species in contrast to the sun coffee plantations, which are characterized by a predominance of matorral or brushland species. The latter species are not usually threatened with habitat loss given their ability to use human-disturbed habitats in the Caribbean.

How Long do Birds Reside in These Plantations?

The real proof of the value of shade coffee as habitat for birds is that birds will reside in these plantations as long as those found in natural, undisturbed forests. We have examined this issue in nearctic migratory birds, which commonly overwinter in forested regions of the Caribbean including shade coffee plantations. Our studies in coffee indicate that about 65 - 75% of the individuals that were present on a site in October and November were still there in March and April before their spring migration (Wunderle and Latta 1994). These results are comparable to those values found in natural, undisturbed forests in the Caribbean and indicate that the shade plantations provide the migrants with resources equivalent to those needed for survival in natural forests.

Our studies of resident bird species are more limited, but we do know that some species can survive in these Dominican shade plantations for at least 3 years. In addition, we have found eight species of residents breeding in the shade coffee plantations, indicating that the plantations provide the resources

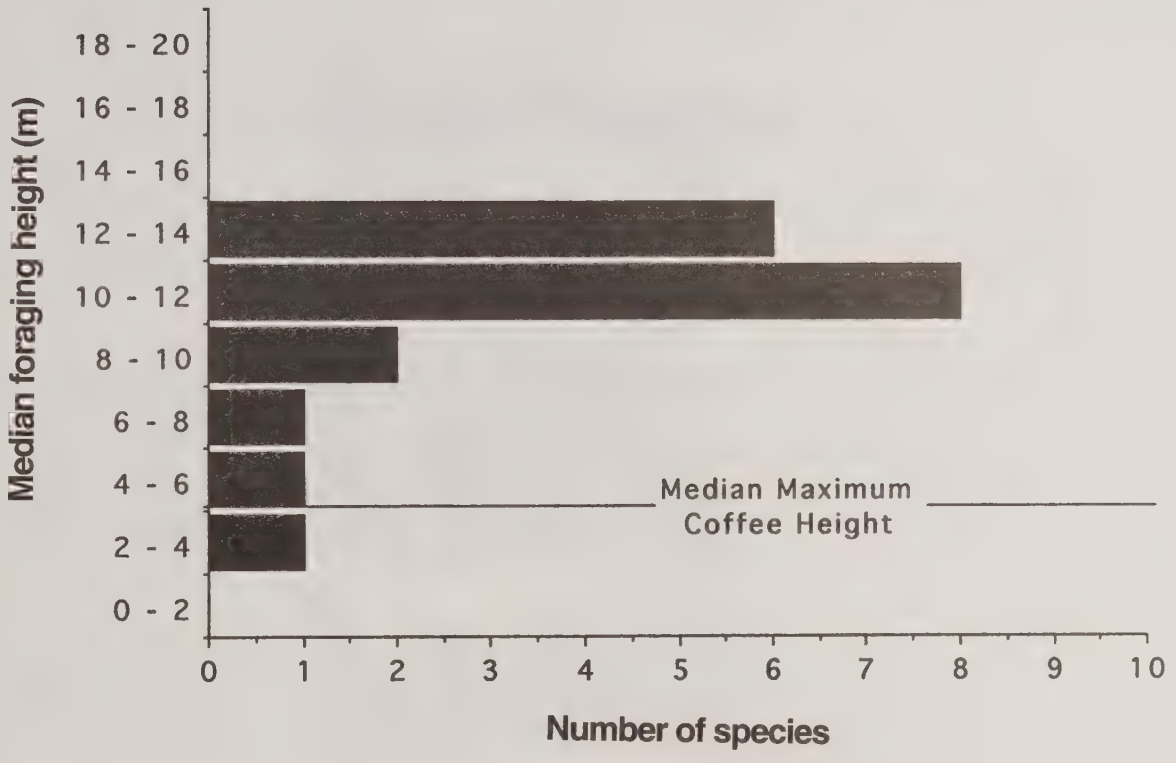

Figure 1. - Median foraging heights of 19 bird species found in shade coffee plantations in the Dominican Republic. Note that 18 of the 19 species have median foraging heights significantly above the median maximum coffee height. This indicates that, for most birds foraging in these plantations, the shade overstory is the preferred site for feeding and the major attractant.

and cues to stimulate reproduction (Wunderle and Latta 1996). However, it remains to be determined if reproductive success in shade plantations is equivalent to that in natural forests. Nonetheless, shade plantations seem to provide many Caribbean species adequate resources for long-term survival.

THE MANAGEMENT MESSAGE

For managers concerned with the conservation of wildlife diversity in agroforestry plantations, the important message is that ***diversity begets diversity***. Plantations with the highest planned diversity will have the highest associated biodiversity, including the diversity of wildlife (fig. 2). A plantation's planned diversity refers to the diversity provided by the farmer and includes both its structural diversity and its plant species diversity. The coffee plantations with the greatest structural diversity of shade overstory trees (i.e., tall trees with many horizontal layers of leaves above the ground) and highest diversity of tree species in the overstory will be most attractive to a diversity of wildlife, especially forest dwellers. The traditional rustic plantation, shown at the top of figure 2, is an example of a plantation with the greatest attractiveness to forest wildlife. As the planned diversity of structure and plant species declines in a plantation, the attractiveness to forest wildlife will also decline (fig. 2, moving from upper to lower).

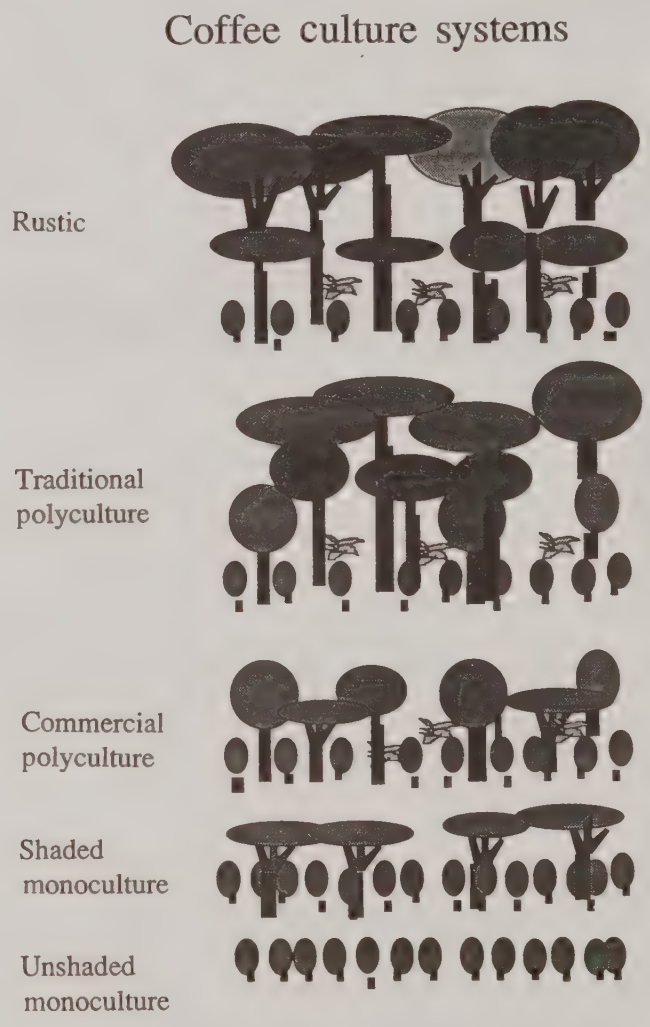

Figure 2. - Five major coffee production systems according to management of the shade overstory in Mexico (Fuentes-Flores 1979), which is also relevant to the Caribbean. Plantations with the greatest structural and plant species diversity, particularly in the shade overstory (top), are more attractive to forest wildlife than plantations with low structural and plant species diversity, especially as found in the sun coffee plantations (bottom).

Our studies indicate that a coffee plantation's attractiveness to birds is enhanced by the abundance, variety, and consistency of food resources. This applies mostly to the shade overstory or plantation border, as the coffee bushes alone provide limited food resources or foraging substrates for most species. A diversity of plant species in the overstory or border attracts more birds, particularly if the plants are asynchronous in flowering and fruiting, thereby extending the time over which resources are available in a plantation.

I have not discussed the issue of pesticides, as pesticide use tends to be rare in shade coffee plantations. However, pesticide use is a concern in many agricultural regions because its use is hazardous to wildlife. Therefore, crops requiring pesticide use, regardless of the tree cover, are likely to have limited value to wildlife. Obviously, organic agriculture is to be encouraged, particularly for those crops that can be certified as organic and thus command a premium price.

The focus of my discussion has been on birds in shade coffee, reflecting our recent research. However, many other forest-dwelling plants and animals inhabit shade coffee, including orchids, various insects (many beneficial), reptiles, and amphibians, and mammals, (reviewed in Perfecto *et al.* 1996). Many of our findings undoubtedly apply to other types of agroforestry plantations including cacao. Agroforestry plantations can serve as valuable buffer zones around forest reserves isolated in agricultural landscapes by extending the area covered by overstory canopy. The issue here for wildlife conservation is keeping a diversity of mature trees in agricultural landscapes. Even with crops such as banana, wide, tree-filled windbreaks should be encouraged as corridors or "stepping stones" for some forest species as they move between forest patches.

AN ECONOMIC INCENTIVE FOR SHADE COFFEE GROWERS

To encourage coffee farmers to retain their shade overstory, an effort is underway to promote the labeling of coffee packages designating a shade plantation origin (Greenberg 1994, Rice *et al.* 1997, Wille 1994). This labeling scheme encourages environmentally concerned consumers to purchase shade coffee, thereby using the marketplace to promote the maintenance of shade canopy trees in some tropical agricultural landscapes. Educating coffee drinkers about the ecological benefits of shade coffee can provide an economic incentive for coffee growers to continue growing coffee in shade plantations. However, for shade coffee to succeed commercially, coffee drinking environmentalists must be willing to pay more for their coffee. Fortunately, the premium price consumers pay for eco-friendly coffee is modest, and many consumers have demonstrated a willingness to pay more for a fine tasting coffee that benefits the environment. Already, several companies and organizations are marketing eco-friendly coffee, with direct economic benefits to those growing shade coffee (Shalaway 1998). Such a labeling scheme for eco-friendly bananas has been in place for several years in Costa Rica. Its use should be considered for other agricultural products that have the potential to benefit the environment and biodiversity.

SUMMARY

Caribbean forest managers face many challenges in their efforts to conserve terrestrial wildlife diversity given the traits of island wildlife including: high vulnerability to extinction, large number of endemic species, vulnerability to stresses from habitat loss and degradation, and forests as the key habitats for most threatened Caribbean wildlife. Given the high human population densities and resulting demands for agriculture placed on most island habitats, few options exist for managers to ameliorate the effects of habitat loss. However, certain types of agroforestry plantations, such as traditional cacao and shade coffee plantations, can provide habitat for some forest wildlife. For example, the overstory of shade coffee plantations attracts various woodland species and may serve as a refugia for some species in deforested areas. In addition, such plantations can serve as valuable buffer zones for forest reserves. Some farmers now have an economic incentive for retaining their shade overstories because of labeling eco-friendly coffee so that environmentally conscious consumers can purchase shade coffee. Such a labeling scheme for other eco-friendly products from agroforestry plantations should be considered for keeping trees in agricultural landscapes in the Caribbean.

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LITERATURE CITED

Borrero, J.I. 1986. La substitucíon de cafetales de sombrio por caturrales y su efecto negativo sobre la fauna de vertebrados. Caldasia 15:725-732.

Brash, A.R. 1987. The history of avian extinction and forest conversion on Puerto Rico. Biol. Conservation 39:97-111.

Fuentes-Flores, R. 1979. Coffee production systems in Mexico. Pages 60 – 71 in F. De las Salas, (editor). Workshop on Agroforestry Systems in Latin America. CATIE, Turrialba, Costa Rica.

Greenberg, R. 1994. Coffee and birds. Smithsonian Magazine, November pp 24-27.

Greenberg, R., P. Bichier, A. Cruz Angon, and R. Reitsma. 1997a. Bird populations in shade and sun coffee plantations in central Guatemala. Cons. Biol. 11:448-459.

Greenberg, R., P. Bichier, and J. Sterling. 1997b. Bird populations in rustic and planted shade coffee plantations of eastern Chiapas, Mexico. Biotropica 29:501-514

Perfecto, I., R.A. Rice, R. Greenberg, and M.E. Van der Voort. 1996. Shade coffee: a disappearing refuge for biodiversity. Bioscience 46:598-608.

Rice, R.A. and J.R. Ward. 1996. Coffee, conservation, and commerce in the western hemisphere. Smithsonian Migratory Bird Center. Washington D.C.

Rice, R.A., A.M. Harris and J. McLean (editors). 1997. Proceedings of the first sustainable coffee congress. Smithsonian Migratory Bird Center, Washington D.C.

Shalaway, S. 1998. A taste for shade-grown coffee. Birder's World. June pp. 78-80.

Vannini, J.P. 1994. Nearctic avian migrants in coffee plantations and forest fragments of south-western Guatemala. Bird Cons. Internat. 4:209-232.

Wille, C. 1994. The birds and beans. Audubon 96:58-64.

Wunderle, J.M., Jr. (In Press). Avian distribution in Dominican shade coffee plantations: area and habitat relationships. J. Field Ornithology.

Wunderle, J.M., Jr. and S.C. Latta. 1994. Overwinter turnover of Nearctic migrants wintering in small coffee plantations in Dominican Republic. J. fur Ornithologie 135:477.

Wunderle, J.M., Jr. and S.C. Latta. 1996. Avian abundance in sun and shade coffee plantations and remnant pine forest in the Cordillera Central, Dominican Republic. Ornithologia Neotropical 7:19-34.

Wunderle, J.M., Jr. and S.C. Latta. 1998. Avian resource use in Dominican shade coffee plantations. Wilson Bull. 255-265.

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CONCLUSIONS FROM THE 9TH CARIBBEAN FORESTERS MEETING

Plenary and small group working sessions produced the following observations and recommendations.

BENEFITS OF BIODIVERSITY

1. Food, medicine, timber and fiber, spiritual/ cultural uses
2. Bioprospecting, pharmaceutical drugs
3. Recreation and ecotourism
4. Watershed protection
5. Economic benefits, *i.e.*, exports
6. Maintaining a diversified gene pool to respond to changing conditions and the evolutionary process
7. Increasing management choices (integrated pest management, choice of timber species, *etc.)*
8. Moral and spiritual satisfaction
9. Education and research
10. Ecosystem stability
11. Pest control
12. Soil protection
13. Artistic inspiration
14. Aesthetics

THREATS TO BIODIVERSITY

1. Loss of ecosystems (change in land use/cover, habitat fragmentation and destruction)
2. Over-utilization of natural resources (mining, forest, marine)
3. Pollution (chemical, land/water/air, industrial)
4. Introduction of exotic species with adverse impacts
5. Climate change
6. Population growth and growth in demand for goods/services (urban sprawl, roads, housing)
7. Illegal trade in animals and plants
8. Inadequate institutional capacity and legal framework
9. Inadequate environmental education/cultural heritage, lack of knowledge/awareness
10. Hidden political agendas/lack of political support
11. Poverty (poaching, squatting)
12. Cultural practices (*e.g.* slash/burn, clearing of land for agriculture)
13. Lack of funds
14. Disturbances triggered by humans (floods, fire, drought, *etc.)*

MANAGEMENT METHODS

Management methods discussed that can help mitigate the identified threats:

1. Assess and inventory biological resources.
2. Establish protected areas, conservation areas, ecological reserves, and refuge corridors in lowlands.
3. Cooperate with key stakeholders (*i.e.* decentralize efforts, share equity).
4. Promote environmental education and training.
5. Establish community enterprises that benefit from ecosystem co-management.
6. Identify sources of funding and technical support.
7. Establish appropriate legal/political framework, and enforce legislation.
8. Foster off-site conservation (zoos, botanical gardens), establish gene banks.
9. Promote native species, reintroduce species.
10. Reclaim, rehabilitate, and restore damaged ecosystems.
11. Support "green technology" (environmentally friendly products).
12. Support monitoring, evaluation, and research of implemented management methods.
13. Make use of modeling (simulation).
14. Enhance habitats (*e.g.* multi-story agroforestry).

IMPLEMENTATION

Ways we can position our agencies, both nationally and regionally, to implement recommended management methods:

Activities We Can Execute Independently

1. Conduct public awareness campaigns, develop National Environmental Education and Training Plan, re-educate decision-makers (politicians).
2. Exchange information, using existing channels (FAO Technical Network, internet capabilities, databanks). Identify and exchange regional expertise and resources.
3. Identify and explore funding and technical assistance sources (*e.g.* IITF, TNC, bilateral donors, university partnerships, *etc.).*

Activities We Can Implement with Some Assistance from Other National and/or Regional Entities

4. Sign and implement international treaties and conventions.
5. Establish a National Environmental Action Plan/Biodiversity Management Plan, from which activities such as the undertaking of a forestry development program would stem, including planting species adapted to local conditions, using scientific and technical knowledge and experience from other tropical regions.
6. Conduct environmental inventories, develop a database to obtain and share information on biodiversity.
7. Build institutional and personnel capacity (train for expertise, identify country's needs, *i.e.* GIS, biodiversity management, inventories, training of customs officials).
8. Collaborate and cooperate with regional agencies.
9. Develop and implement a training program for GIS GPS and remote sensing using data from countries to form a regional database.
10. Establish a Biodiversity National Coordinating Body.

Activities We Can Only Recommend to National and/or Regional Governing Bodies

11. Strengthen institutional enforcement.
12. Improve legal framework, evaluate, rationalize, and formulate policies or underlying legislation relevent to managing biodiversity (most policies are outdated and emphasize bird conservation). Reform legislation to encompass national, and regional as well as global biodiversity objectives.
13. Initiate comprehensive land-use planning that considers ecological principles (*i.e.* for land under country's forest management plan).
14. Promote and establish programs to control threats to biodiversity such as pollution and population growth.
15. Integrate poverty-alleviation programs into conservation efforts; recognize that people are part of the ecosystem and take their needs into account.
16. Support "environmentally friendly" investments, provide economic incentives, identify and support markets. (Consider application of taxation and subsidies.)
17. Request governments allocate a representative part of country's ecosystems as a biological reserve.
18. Establish a regional body comprised of representatives of national bodies (Biodiversity International Coordinating Body).

Other Activities

19. Develop national and regional curricula for biodiversity issues (Min. of Education, NGO's, and others); then develop regional biodiversity education awareness programs aimed especially at primary and secondary schools, including information on regionally endangered species.
20. Adopt a no-net-loss policy (sustainable use).

TRAINING SUGGESTIONS

1. GIS:
   Before conducting a regional training session, gather information from each country on current state of use and potential applications.
2. Forest inventory:
   All stages of site specific inventory
3. Reforestation and management:
   Seed collection, nurseries, plantations, maintenance

NOMINATED THEMES AND VENUES FOR 10TH CARIBBEAN FORESTERS MEETING IN YEAR 2000

Theme:	Venue:
Status of research in the region	Guyana
Community forestry	Puerto Rico
Urban forestry	

The group decided to form an organizing committee for the next CFM. Four candidates were nominated, and three accepted: Michael Andrew from St. Lucia, Sheriff Faizool from Trinidad and Tobago, and Marilyn Headley from Jamaica. In addition, the representative from the hosting country will serve on the committee. The conclusions and recommendations of the 9th meeting will be revisited during the 10th meeting to determine progress and suggest any further definition or prioritizing. Emphasis will be placed on the first 10 recommendations. A new committee will be nominated at each meeting.

ADDITIONAL SUGGESTIONS FOR THE 10TH CFM AGENDA

- Allow 1/2 - 1 day for countries to report on specific studies completed since last meeting and highlight new developments. In the papers presented by each country, focus on where action is in the country, which may not be specifically related to the meeting theme. Don't repeat same information in country reports year after year, *i.e.* location, weather, topography. Include time to follow-up/report on progress in accomplishing specific recommendations made during previous meeting. In addition to informing about current events, it is hoped that this approach will help build bilateral relationships.
- Leave time on the agenda for "open issues."

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